

The Earth Stands Fast.

A Lecture by
PROFESSOR C. SCHOEPFFER.

Translated for and Edited by
J. WATTS DE PEYSTER.

With Notes and a Supplement by
FRANK ALLABEN.

"He founded the Earth upon her bases that it should not be moved forever."

Psalm civ. 5; A. V. & R. V., both, margin.

NEW YORK :

CHARLES H. LUDWIG, PRINTER, 90 WALKER STREET.

1900.

CONCLUDING REMARKS.

We conclude this interesting discussion by citing two authorities. The nature of the "proof" we have of Newton's law has been stated as follows by Prof. Henry A. Rowland, in his remarkable address as President of the Physical Society of America, on "The Highest Aim of the Physicist," read at the meeting of that society in New York, October 28, 1890, and printed in the *American Journal of Science*, for December, 1899:

"Newton and the great array of astronomers who have succeeded him have proved that, within planetary distances, matter attracts all others with a force varying inversely as the square of the distance. But what sort of proof have we of this law? It is derived from astronomical observations on the planetary orbits. It agrees very well within these immense spaces; but where is the evidence that the law holds for smaller distances? We measure the lunar distance and the size of the earth and compare the force at that distance with the force of gravitation on the earth's surface. But to do this we must compare the matter in the earth with that in the sun. This we can only do by *assuming* the law to be proved. Again, in descending from the earth's gravitation to that of two small bodies, as in the Cavendish experiment, we *assume* the law to hold and deduce the mass of the earth in terms of our unit of mass. Hence, when we say that the mass of the earth is five and one-half times that of an equal volume of water we *assume* the law of gravitation to be that of Newton. Thus a proof of the law from planetary down to terrestrial distances is physically impossible.

"Again, that portion of the law which says that gravitational attraction is proportional to the quantity of matter, which is the same as saying that the attraction of one body by another is not affected by the presence of a third—the feeble proof that we give by weighing bodies in a balance in different positions with respect to each other cannot be accepted on a larger scale. When we can tear the sun into two portions and prove that either of the two halves attracts half as much as the whole, then we shall have a proof worth mentioning.

"Then as to the relation of gravitation and time what can we say? Can we for a moment suppose that two bodies moving through space with great velocities have their gravitation unaltered? I think not. Neither can we accept Laplace's proof that the force of gravitation acts instantaneously through space, for we can readily imagine some compensating features unthought of by Laplace.

"How little we know then of this law which has been under observation for two hundred years!"

We may also cite Professor Rowland's caution against the supposition that ability to work out a mathematical theory for an hypothesis adds a single grain of real proof to that obtainable for the hypothesis from experimental observations of nature alone. On this point he says, in the above address:

"A mathematical investigation always obeys the law of the conservation of knowledge; we never get out more from it than we put in. The knowledge may be changed in form, it may be clearer and more exactly stated, but the total amount of the knowledge of nature given out by the investigation is the same as we started with."

It is not generally known that the great Danish astronomer, Tycho Brahe, and not Copernicus, Kepler or Newton, was the pioneer of the true scientific method in astronomical research, which observes Nature in order to understand her laws, instead of seeking to force her phenomena to square with preconceived theories. The contributions to astronomical science of this "father of modern astronomy," as he was in truth, are briefly recounted by the late Prof. Richard A. Proctor, in his treatise on "Astronomy," which occupies some eighty pages of the "Encyclopedia Britannica," Ninth Edition (Vol. II., pp. 744-823). The following is taken from page 752 of that article:

"Tycho Brahe stands next in chronological order on the roll of those who have contributed to the progress of astronomy. As an indefatigable and skillful observer, he is justly considered as far superior to any astronomer who had preceded him since the revival of the science in Europe. His ample fortune gave him the means of procuring the best instruments which the age could produce; and by his ingenuity and persevering application, he was admirably qualified to

THE
EARTH STANDS FAST:

A Lecture

DELIVERED BY

PROFESSOR C. SCHOEPPFER,

Seventh Edition, published in Berlin, in 1868.

TRANSLATED FOR AND EDITED BY

J. WATTS DE PEYSTER,

BRIGADIER-GENERAL AND BREVET MAJOR-GENERAL,

M. A., LITT. D., PH. D., LL. D.

"He hath made the round world so sure that it cannot be moved."

PSALM (PSALTER) xciii. 2.

WITH NOTES AND SUPPLEMENT BY

FRANK ALLABEN,

HISTORIOGRAPHER AND SCIENTIST.

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JOHN WATTS DE PEYSTER.

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INTRODUCTORY REMARKS.

Four years ago I was riding with an investigating friend in the country, discussing how it was that God should have selected the earth as the theatre of his revelations to the Jews and to the Christians. Then one of us suddenly remembered that a German professor, Dr. C. Schoepffer, in a public lecture in Berlin, had maintained the truth of the Tychonian theory, founded on the supposition that the earth stands still in space, that the sun revolves around the earth, and that the planets and other members of our solar system revolve about the sun. So far from being ridiculed, this startling proposition of Tycho Brahe, suddenly revived about three centuries after its announcement by the famous Dane, received serious attention, and the facts on which Dr. Schoepffer based his arguments were felt to be incontrovertible, whatever judgment may be passed upon his conclusions.

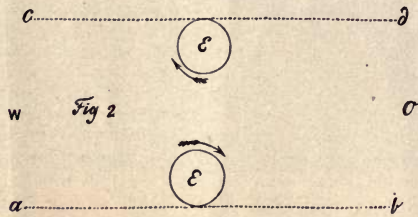
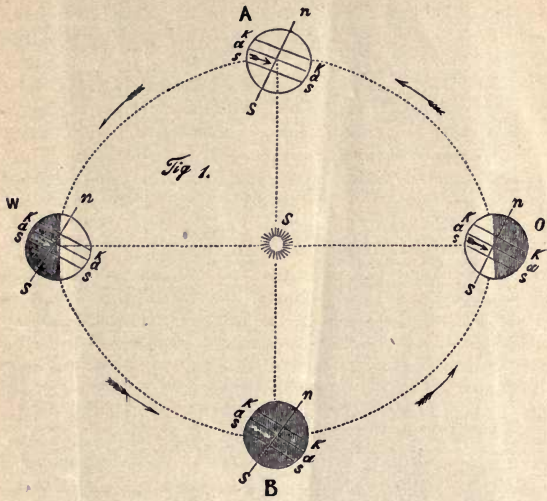
The laws which govern the heavenly bodies, and those on which astronomical calculations have hitherto been founded, were long considered unerringly certain and irrefutably fixed, such as those of gravitation, the aberration of light and stellar parallax, and were not deemed subjects of legitimate controversy; but experts of the highest order are now by no means agreed as to the actual forces or laws which govern the physical universe, the postulate of which was hitherto considered infallible.

After discussing the matter one of us remarked: "If Schoepffer is right that establishes the literal truth of the Bible." The other replied: "*Rem acu tetigisti!*"—vulgarily translated, 'You have hit the nail on the head!'"

Without pretending to come forward as a Herschel or a Laplace, any hypothesis which a professional scientist has the courage to publish, in a country filled with learned men, and which is there treated without ridicule, must have some force in it. Consequently this German pamphlet, carefully translated, is presented to American readers with a simple request, that whoever receives it will read it with attention and reflect upon its scientific arguments and presentation, before throwing it aside as "a weak invention of the enemy."

J. WATTS DE PEYSTER (ANCHOR),
A. M., Litt. D., Ph. D., LL. D.

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References to pages 12 and 13.

THE EARTH STANDS FAST.

PROOFS THAT THE EARTH REVOLVES NEITHER UPON
ITS OWN AXIS NOR YET ABOUT THE SUN.

[A Translation from the German of a Lecture delivered in Berlin, by Dr. C. Schoepffer. Seventh edition. Berlin : A. Saco, Successors, Publishers, Zimmerstrasse, No. 94. 1868.]

Compared with the Original and Edited by J. W. de P.

GENTLEMEN :

It requires not a little courage to stand before you here to demonstrate the erroneousness of an opinion which you have thought the only true and correct one since the years of your childhood. I believe I may judge of the opinion you have of me this moment by that which I should have had myself three months ago of him who should assert to me that [138] *the Earth stands immovable and the Sun is revolving about it*. Such a man I should have considered either very ignorant or a lunatic ; and yet now I regard the fact of the stability of the earth as a truth which cannot be shaken. Moreover, I believe that those of you who are without prejudice and free from prepossessions and will examine what I am going to lay before you will soon share my opinion.

Not long ago we had an opportunity of seeing the tests with the pendulum which, according to the theory of the widely-known physicist, Mr. Leon Foucault, are said to furnish the proof of the daily rotation of the earth upon its axis. I had well-nigh failed to take any notice of those Pendulum tests. Although, when explaining to my pupils, boys and girls, in my geographical and physical lessons, the revolution of the earth about the sun, I had always found one point (which you will learn in the course of my lecture) very strange—nay, incomprehensible—yet I was so convinced of the daily rotation of the earth, and its yearly course round the sun, as to deem Mr. Foucault's pendulum-proof entirely superfluous. Nevertheless, I was present at the experiment, and I will explain it in a few words, to make the application clear.

If we imagine around the earth's sphere a limited—or unlimited—number of circles, parallel with the equator, we call these circles, precisely on account of their parallelism with the equator, parallel circles. It follows, from the spherical form of the earth, that the circles become smaller the nearer we place them to the poles ; and if we should imagine two parallel circles drawn around the earth through this lecture-room, the northern one, even

thus, would be somewhat smaller than the southern one. Let now the earth revolve in twenty-four hours upon its axis, so that the two imaginary circles laid through this room have made a complete rotation. As both have made their circuit in equal time, and as the southern one is larger than the northern one, the single parts of the one to the south must move with greater rapidity than those of the one to the north.

Let us glance briefly at the instrument, so widely-known and yet in many respects an enigma, which we will call the pendulum. It may be shown that the even oscillation of the Pendulum is independent of the alterations (rotations) of its point of suspension. This immutability of the even oscillation was said by Mr. Foucault to prove the rotation of the earth upon its axis. If, for example, we let a pendulum oscillate in a direction from north to south, across the two parallel circles which we have in imagination drawn through this room, then will its even oscillation, as Mr. Foucault assumes, be unaffected by the rotation of the plane (or point of suspension), and consequently will move in advance of the northern, more slowly rotating, parallel circle, but will fall behind the southern, more rapidly rotating parallel circle. The path of the pendulum will, therefore, soon deviate from the direction, north to south, the end formerly swinging to the north swinging more and more towards the east, and the end swinging southward more and more towards the west, until finally the pendulum swings entirely in the direction from east to west. At this point the cause of deviation has ceased; for the pendulum swings no more across two unequally-rapid parallel circles, but across a single circle. As the cause of deviation no longer exists, the deviation ought to cease. *But no, it continues! the pendulum also leaves the direction, east to west, to deviate to southeast and northwest, and thus reaches conditions under which, according to Foucault, it must deviate again!*

Now, as the pendulum does not remain in the direction from east to west, but also deviates from this, I think I am entitled to the belief that the deviation of the pendulum is caused by something other than the rotation of the earth—something, it is true, which is still unknown to us. Furthermore, I have found, by careful experiments, that the deviation is not the same with all pendulums. The heavier the bob, the slower becomes the deviation of the pendulum; the lighter the bob, the more rapidly the deviation takes place. Since the rotation of the earth upon its axis, if existing, must be a uniform one, necessarily with all pendulums the deviation should be uniform; but this is not the case.

The conviction that the Foucault experiment with the pendulum was erroneous made me examine more carefully the further reasons from which, heretofore, the rotation of the earth upon its axis was inferred; and thus I perceived that there had been no demonstration whatever of such a supposition.

Long ago the Indian, Brahmagypta, the Pythagorean, Philolaus, Niketas of Syracuse, and Aristarch of Samos (who was born 267 B. C.), asserted that the star-sphere is immovable, and that the earth, revolving upon its axis,

Maintain the same position
irrespective of distance

causes the daily rise and set of the celestial bodies. These men, who were all profound thinkers, accepted the opinion cited because they could not comprehend the velocity with which the celestial bodies must fly to compass their daily courses round the earth in twenty-four hours. But in our times every one will concede that this objection is without force. Tell a country lad, in a place where there is yet no railroad and only wagons are possessed, that we can make a mile in five minutes, and he will think this utterly impossible. And yet we know that light travels 40,000 miles a second, and that the velocity of electricity is still greater.* Therefore, gentlemen, the argument is rendered void, that celestial bodies (having their orbits in a space which, according to our supposition, is either vacuous or filled with a very thin matter of the nature of which we know nothing definite yet) could not have such a velocity as to finish their course around the earth in twenty-four hours.

Let us now dwell upon another argument which has been accepted, but which is equally void. Measuring the meridians of the earth, we have found that the earth is flattened towards the poles, and that a diameter of the equator is larger than an axis from pole to pole. Man, who tries to penetrate all the secrets of nature, attempted, alas, to investigate the cause of this flattening towards the poles, and Newton thought to find the cause in the rotation of the earth. By this motion all particles of the globe, especially the bodies on the surface, are said to have an impulse to fly away from the earth, and this opinion is, in agreement with Newton, accepted by all. This tendency is called centrifugal force. At the poles, where the velocity of rotation is zero, this force would be equal to zero, and would increase thence to the equator in proportion to the size of the parallel circles; for, as I have already remarked, the greater the parallel circle the more rapidly each point of it must move—provided the earth actually rotates upon its axis. It is said, therefore, that much more of the mass of the earth is pressed toward the equator, and a much greater mass is accumulated around the equator, for here the centrifugal tendency acts with the greatest force. Hence, they assert, the earth must revolve, for without the rotation of the earth the centrifugal tendency would not exist, and without the centrifugal tendency there would be no accumulation of greater masses in the equatorial zones.

We have here another alleged proof of the rotation upon the axis which I cannot accept, and which has been repudiated by others before me.

I am far from objecting anything to the correctness of the measurements

* These figures are quite as obsolete as is the idea of railway-speed. The lecture was delivered in 1854. The velocity of light is now estimated at 186,000 miles per second through the air, while the velocity of electricity, through the air as a medium, is said to be about the same as that of light, suggesting a connection between the two things. The discharge of electricity from a Leyden jar over a copper wire, Wheaton estimated at 288,000 miles per second.

of the degrees, although the measurements made on various occasions do not in the least agree. We will take it for granted that a diameter of the equator is larger than the length of the earth's axis. Are there, however, no other and nearer-lying reasons which might have caused a larger accumulation of masses at the equatorial latitudes? It is known that heat has an expanding, cold a contracting force. Is it not possible that, during the unnumbered thousands of years since our earth came into existence, the tropical heat has caused the continuous expansion of the equatorial latitudes, while the cold of the poles has caused the continuous contraction of the polar regions?

There is, however, still another and nearer reason why the larger accumulation of masses in the equatorial latitudes has originated. The earth seems to be in a state of continuous growth, and the flora and fauna add very much to this growth. It is neither here the place, nor have we the time, to speak of the immense coal strata which we find at considerable depths (and still more of which we shall find as soon as we succeed in penetrating deeper into the earth). Likewise, it would lead us too far if I undertook to tell you of the animal remains, partly microscopic, which form whole mountains and strata. I merely mention the fact that turf moors grow upon many of our higher mountain-chains, and that our farmers produce a stratum of humus upon rocky ground by laying out meadows, because they know that a stratum of earth is generated by the growth of the sod. And now, let me ask, where could this growth, by faunal and floral remains, go on with greater effect:—in the warmer regions, where fauna and flora abound, or in the polar regions, where there only is a reduced life which constantly decreases the nearer you approach the poles?

Now, gentlemen, so long as simpler reasons are offered to us in explanation of how the accumulation of masses in the warmer zones has taken place, in the course of so many thousands of years, I cannot make up my mind to accept this as a result of a centrifugal tendency caused by the rotation of the earth upon its axis; and this the less as, later on, I shall call your attention to some contradictions in which this theory of centrifugal tendency would entangle us.

I now go on to the fourth and last consideration by means of which the rotation of the earth is thought to be demonstrated. The Frenchman, Richer, observed in the year 1672 that a pendulum clock going normally in Paris lost daily two and one-half minutes in Cayenne, i. e., five degrees north of the equator, and he had to shorten the pendulum by one-eighth of an inch to make it go correctly. It is known that the velocity of a pendulum increases with its shortness and decreases with its length. Later on it was found that upon high mountains also a noticeable slackening of the oscillations of the pendulum took place. Now, since the oscillations of the pendulum are based upon the Laws of Gravity—that is to say, depend upon the attraction of the earth—the attraction under the equator and upon high mountains must thus of necessity, it was argued, be less, since the pendulum

there makes slower oscillations; and it was concluded that the centrifugal tendency caused by the motion of the earth upon its axis reduced the gravity, and consequently made the movement of the pendulum slower. But this conclusion also lacks infallibility, for we may just as well suppose that the attraction of the earth diminishes with the distance from its centre, which is at the same time the centre of attraction; and this is an hypothesis which has been accepted by quite a number of physicists.

But what if the slackening of the oscillations of the pendulum in middle latitudes and upon high mountains has a cause which is quite the opposite of that so far accepted? What if it be true that the attraction is not diminished by the distance from the centre of the earth, nor by the centrifugal tendency, but that an increased attraction, increased by the accumulation of masses, is the cause of the slackening of the oscillations of the pendulum by thus augmenting the weight of the bob of the pendulum? For it is a fact—which seems to be unknown to many philosophers, although most of the old village schoolmasters are aware of it—that the quicker or slower movements of the pendulum do not depend exclusively upon its length, but also upon the weight of the bob. One might perhaps say that the velocity of the oscillations of the pendulum depends exclusively upon the weight of the bob, for when lengthening the pendulum I make the bob work on a longer lever, and therefore increase its weight. Hence I may obtain the same result by increasing the weight of the bob, instead of lengthening the rod of the pendulum. The village clock goes too fast, and the schoolmaster attaches stones or pieces of iron to the bob of the pendulum in order to slacken the oscillations of the pendulum. Laugier has made the most accurate observations in this line. He found that one and the same pendulum, with a bob of 2 kilograms weight, required 1,977 seconds for 2,000 oscillations; with a bob of 4 kilograms, required 2,010.55 seconds; with a bob of 6 kilograms, 2,020.04 seconds; with a bob of 8 kilograms, 2,027.04 seconds—the number of oscillations in each case being the same. Hence the larger the weight of the bob, the slower the oscillations of the pendulum. The deductions from these observations—carried out with the utmost care, and published in the "*Comptes Rendus de l'Académie Française*" (t. xxi., pp. 117-124)—are as follows: (1) The laws of Galileo in regard to the oscillations of the pendulum are not exactly correct; (2) the decrease of the attraction of the earth toward the equator, inferred from the decrease of the velocity of the pendulum, is probably wrong; (3) the laws of falling bodies, so far universally accepted, are also probably not exact; (4) calculations of physical laws in general are always untrustworthy, as only experience can decide.

We have seen (from the two considerations last mentioned as advanced to prove the rotation of the earth upon its axis) that an influence of this rotation is conjectured, working as a centrifugal tendency caused by this rotation. Currents of the ocean and of the atmosphere were also thought to be consequences of this centrifugal tendency. Indeed, it is diffi-

cult to comprehend how it is possible that air (this light body, moved by the most diverse currents, seeking expansion, and so loose and volatile) should not be affected by the rotation of the earth. After the greatest philosophers have postulated an influence of the rotation of the earth upon the solid mass of the body of the earth, surely I do not consider it too presumptuous if I assume that the rotation of the earth must of necessity influence the air! It is not possible, as I conceive, that the lighter air of the higher regions, especially, can follow the globe of the earth when it is rotating with considerable rapidity. The earth, rotating towards the east, would cause an air current toward the west. Were the universe, where the earth is rotating with its air-belt, perfectly vacuum, we might perhaps—I say, perhaps—accept the view of a rotation of the earth without influence upon the air-belt; but the nature of the air contradicts the thought of such a vacuum-state. So far as we know, the air possesses such a tendency toward expansion as partly to neutralize by it the laws of gravity. Did not the extremely thin air find a body in the universe to preserve its equilibrium, it would expand still further, the air-layers next would follow, and finally also the entire body of water would have its part in this expansion and fly out into the universe, exactly as we may produce like phenomena of expansion under the air-pump. There must, therefore, be in existence a materia which preserves the equilibrium of the outermost air-layers—a materia which, according to universal usage, we will call ether; and it thus follows that the air cannot escape into endless space—nay, each layer must press upon the next lower one, and by this gradually increased pressure is caused the greater density of the air-layers next to us.

But if there is an ether (the existence of which also seems to be confirmed by the meteorites), then with a rotation of the earth such well-known effects must appear in the air-layers as always arise from the resistance of a moving current of air. If now we set the earth in motion, the outermost air-layer will hang back, through the opposition of the ether (provided the entire air-belt is forced, by attraction, to partake of the rotation), and will appear to move in the opposite direction. If this should take place, the outermost air-layer would likewise exert a pressure upon the next lower air-layer, this would share in the current contrary to the rotation of the earth, and in this manner the contrary current would increase and gradually grow in such a degree that finally the entire air-belt, and likewise all the water of the globe, would turn eastward.

Even suppose, however, that there is no ether, but that its existence ranks among the numberless dreams in which man has been indulging while attempting to explore the *universal*, without being able to apply another measure in his researches than that of our earthly state, I should yet claim that air cannot participate in the rotation of the earth.

How do our philosophers explain the fact of our not noticing anything of the assumed rotation of the earth?—or why, with this rotation, all things

are not toppling over one another? They explain it by the laws of communicated motion. Very well! I will again turn their weapon against themselves. A motion may be communicated to solid bodies; but to such, however, as have no connection in their parts, can only be communicated when they are enclosed in a solid body! But we know of no body the parts of which have much less connection with each other than is the case with the air. The air-layer next to the earth, really dragged along by the communicated motion, would not be able to communicate its motion to the layers above it, for the simple reason that it stands in no connection with them. These upper layers must therefore remain in their place, or (which would signify the same thing) would apparently flow westward with the same rapidity with which the earth is said to rotate to the east. Now, since a point on the equator (if the earth rotates on its axis in a day) must move eastward at the rate of 1,250 feet a second, the air would similarly move 1,250 feet westward in a second, which would more than ten times surpass the velocity of the most fearful hurricane.

It is not myself, however, who am the first to conceive the necessity of this current of the air westward. All philosophers of the present time have admitted the necessity, but have been unable to find any proofs of its existence. The Trade Winds, which for a while were looked upon as results of the rotation of the earth, lack too much in regularity—formerly so highly praised—and, like all other winds, are evidently caused by the differences of temperature over the different regions of the earth's surface. Consider how the air-belt of our globe produces weaker or stronger currents in the most diverse directions, called by us winds or storms; consider that even contrary winds flow one above the other—and ask how, if it had besides to obey the double motions of the earth, upon itself and around the sun, it would be possible with such currents for our air-belt to remain in any wise a faithful follower of our globe!

We cannot perceive the rotation of the earth in any way. We cannot demonstrate it! There are no air-currents which we can justly regard as—or even suppose to be—consequences of this rotation. These facts ought to be proof enough against the existence of a rotation of the earth. Indeed we wholly lack, as I remarked in the beginning, a consideration indicating rotation which can be substantiated. Must it not appear almost absurd in us, preoccupied by what they have taught us in school, to accept a theory of the rotation of the earth which neither is, nor can be, proven? Must we not wonder at the readiness of the learned of nearly the entire world, from the time of Copernicus and Kepler, to accept the conception of the rotation of the earth—and then search afterwards, now for nearly three and a half centuries, for arguments to maintain it, but of course without being able to find them?

More easy will it be for me to prove to you the impossibility of an orbit of the earth around the sun. I shall furnish a counter proof, *ad oculos*.

The theory of the revolution of the earth around the sun—the assertion that it is kept in its course by the force of the sun's attraction—contradicts most positively the laws of gravitation we know; for the direction of gravity with each body must be perpendicular to the point from which the gravity of a larger body works upon it. In the case of a small particle of dust which lies against a smooth wall, the direction of gravity must be toward the wall, or it would drop from it. Similarly, the direction of gravity of our earth should be constantly toward the sun, on the supposition that there is an attraction working from that orb upon it. Yet this is not the case, for if the earth moves in an orbit around the sun, the direction of its gravity necessarily must be changing each moment.* To prove this, let us cast a glance upon the present theory of a yearly revolution of the earth around the sun, as it is given in all the works known to me that treat of this subject.

To explain the change of the seasons, or in other words, the ecliptic of the sun, it is necessary to assume that the axis of the earth has an inclination of $23\frac{1}{2}^{\circ}$ toward the plane of the earth's orbit, and preserves always the same inclination during the entire revolution around the sun, or remains parallel to itself in all points of its course. Let us materialize this theory by taking a candle for the sun, and now lead a globe around it just as the earth would have to move around the sun, to make the change of the seasons possible.

The axis of the earth (Fig. I, *A*—see page 4) is neither turned toward nor from the sun in March. The equator of the earth then revolves directly beneath the sun, which appears in the celestial equator. It shines now from one pole to the other, and a meridian on each side defines the limit of illumination. Everywhere, consequently, day and night are equal, while each place revolves twelve hours in sunshine over the daily arc of its parallel circle, and twelve

* According to the Newtonian theory, every molecule of the earth's mass attracts and is attracted by every molecule of the sun's mass. Thus the earth and sun should always present the same faces toward one another, as if a network of taut wires connected all their molecules. But in contradiction to this, the Copernican theory conceives of the earth as performing a daily rotation on its own axis, thus constantly overcoming the force of gravitation between the molecules of sun and earth. And what causes this axial rotation? The astronomers and philosophers will have some trouble in naming a force so powerful as originally to have inaugurated, and since to have maintained, an axial revolution of a mass of molecules which must needs continuously overcome the gravitational pull of each molecule toward the sun. In the case of the earth and moon, where an attractive force is evident as the power which holds the moon in its orbit, this contradiction does not exist—as Dr. Schoepffer notes, the moon ever presents the same face toward the earth as if all the molecules of her mass were rigidly fixed to the earth by invisible rods. It is a remarkable fact that, in the case of both Mercury and Venus, whose revolution about the sun is a matter of ocular telescopic demonstration, the case is the same as with the moon. The young American astronomer, Lowell, has in recent years confirmed the conclusion of the Italian astronomer, Schiaparelli, some twelve years since, that both Venus and Mercury ever maintain the same face toward the sun throughout their annual orbits, one of the hemispheres of each experiencing perpetual day and the other hemisphere perpetual night.

[F. A.]

hours without sunshine over the nightly arc of its parallel circle. The equator has summer, the northern hemisphere Spring, the southern Fall.

From March till June the north pole of the inclined axis of the earth is gradually turning toward the sun. The entire northern hemisphere inclines toward it until on June 21 (Fig. I, *W*)—the longest day for the northern hemisphere—the sun stands directly above the Tropic of Cancer. The northern hemisphere has Summer, the southern Winter.

From June to September the axis returns again to such a position as neither to be turned toward nor from the sun, wherefore the earth is illuminated, September 23 (Fig. I, *B*), as on March 21. The sun again stands directly above the equator, which has summer the second time, while Fall begins again upon the northern hemisphere, Spring upon the southern.

From September to December the axis of the earth turns its south pole more and more to the sun, which consequently stands directly above the Tropic of Capricorn on December 21. Then an illumination occurs exactly opposite to the one of June 21. The south pole is illuminated and the north pole has its long night. The northern hemisphere has its Winter, the southern its Summer. From December to March the axis of the earth returns to its first position.

For the readers of this lecture a diagram is added—see p. 4. In the middle, at *S*, we see the sun. The dotted circle represents the orbit of the earth, and the arrows indicate the direction of the revolution of the earth. We see the earth in its various positions, at *A*, *W*, *B*, *O*. *W* represents at the same time the western, *O* the eastern direction, while the arrows within the spheres indicate the direction of the daily rotation of the earth from west to east. Of the lines crossing the globes, *aa* represents the equator, *kk* the northern tropic, *ss* the southern tropic, and *ns* the axis of the earth. At *A* one sees the earth on March 21: its axis is turned neither to nor from the sun; its half, turned toward the sun, is illuminated from the north pole to the south pole. At *W* one sees the position of the earth on June 21; the north pole is turned to the sun, the south pole from it; the north pole circle is entirely in sunlight, the south pole circle entirely in darkness. *B* shows the position of the earth on September 22: one sees it half dark, from north pole to south pole turned away from the sun. *O* represents the position of the earth on December 21: the south pole is turned to the sun, the north pole from it. One sees how the axis of the earth always maintains the same direction, remaining parallel to itself, and how only thus can the seasons be explained—if it be supposed that the earth goes round the sun in a year.

Thus far the theory of the modern is all right. But I now come to a point, incomprehensible as yet, and left entirely out of consideration, as mentioned by me in the beginning. This invariably appeared strange to me, as often as I explained the revolution of the earth round the sun in teaching geography or physics.

As it is impossible to assume that the earth revolves in a year round the sun, while at the same time throughout this orbit the sun revolves daily round the earth, we are therefore bound to assume, in order to explain the regular changes of day and night, that during its revolution around the sun the earth also rotates daily upon its own axis, from west to east. These two revolutions, however, can by no means be combined. From June 21 to September 22 both kinds of movement might be thought of as combined (Fig. I, *W* to *B*), but from September 22 back to June 21, the combination of the two movements becomes utterly absurd, because the earth would then rotate daily in an eastern direction, and yet at the same time move forward in quite varying directions! But each rotating body which moves from its place receives the direction of its movement from the kind of its rotation, and *vice versa*, the direction of its rotation from the direction of its movement. If the earth rotates toward the east, it must also move to the east. If at the same time another force acts, enforcing another movement, perhaps to the west, then the one of the two forces which is the stronger must neutralize the other.

If we compare with each other the two halves of the supposed orbit of the earth around the sun (*i. e.*, the half of the orbit from *W* through *BO*, with the half orbit from *O* through *A* to *W*), we find that from *W* to *O* the direction of the rotation somewhat harmonizes with the direction of the movement, whereas from *O* to *W* the direction of the rotation is absolutely contrary to the direction of the movement. This may be seen by leading a rotating globe about a light, as in Fig. I. To explain this striking point, we must assume that the direction of the gravity is constantly changing during the period of a revolution of the earth around the sun—a thing which is really too strange, and does not harmonize with the fact that we are bound to assume that the direction of gravity is toward the sun, since the sun is regarded as the body which keeps the earth in its course. Fig. 2 will explain the matter. The sphere *E*, as the arrows indicate, must constantly rotate toward *O*, and run first from *a* to *b*, and then back from *d* to *c*. Hence necessarily in its course to *O* it must have the direction of its gravity in the line *ab*, while in its course to *W* the direction of its gravity is in the line *cd*, and therefore first downwards, then upwards. True enough, there is no up and down in the universe, but the case remains the same. We shall later on return to the fact that this constant changing of the direction of the gravity of the earth contradicts all our experience.

According to the opinion now prevailing, the earth is kept in its course by the power of the sun's attraction. But either this supposition contradicts the supposed double motion of the earth, or else we must postulate physical laws contradicting each and all our experiences. For it is out of the question to suppose a double motion of the earth, about itself and around the sun, which can be brought into harmony with the changes of the seasons and the change of day and night, and in which at the same time the direction of

gravity is invariably tending toward the sun—which must necessarily be the case if the earth is kept in its course by the attraction of the sun.

The theorists presume that two forces are operative in each circular motion. If, *e. g.*, we tie a ball to a thread and make it go around in a circle, the thread always straightened, one force tends to drive the ball away from the centre in a straight line, and for this reason is called the centrifugal or flying force; while the other, which here is represented by the thread, pulls the ball always toward the centre, and therefore is called centripetal force. Both forces being in operation, the ball can follow no line which is dictated to it by either of the two forces, but will always take a diagonal direction; and out of the composition of these numberless small diagonals, the orbital motion results.

Let us now more closely look into this circular motion, and we shall find that it is a simple one. The point where the thread is tied on (where also, therefore, the centripetal force coming from my hand works) is always directed toward the centre of the motion, *i. e.*, the hand. Should it have still another motion around an axis, the pole of this axis would have to lie at the suspension point, and to remain always in the direction of the hand. But what is law with one body, must be the law with all other bodies under like circumstances.

The only celestial body which is near enough to us to be observed with accuracy is the Moon, and we see her making her revolution around the Earth under the same conditions as the ball in our illustration. Take now the Moon instead of the ball, the Earth instead of the hand, instead of the thread the attraction of the Earth, which though invisible works in the same manner as the thread. Then we see why, indeed, the Moon always turns the same side toward the Earth—for any turning, any changed direction of gravity, is rendered impossible by the force of the attraction of the Earth. Why should we not continue to draw our conclusions from the Moon, since this is so near the Earth? If the Earth is revolving around the Sun, and kept in its course by the attraction of the Sun, then by the constant operation of this very attraction a rotation upon its axis, such as we have to accept with the Copernican system, must be rendered as impossible as it is in the case of the Moon. Then one-half of the Earth would be always illuminated by the Sun, the other half always in darkness. That, again, is contrary to the truth. Consequently, the simultaneous rotation of the Earth upon its axis and revolution around the Sun, as heretofore assumed, are not possible.

Now we might, perhaps, assume that the earth is at the centre, rotating in twenty-four hours upon itself, while the sun yearly makes the circle about it which is called the ecliptic. Such an arrangement would come somewhat nearer the possibility. Yet there is no reason for this assumption, so long as it is not possible to prove the rotation of the earth upon its axis. As yet, however, as we have seen, it is easier to show the contrary.

I have proven this contrary mainly by means of the absence of a constant air-current from east to west. For the same reason, if the earth were to

circle about the sun, the air-belt would stay back towards the side opposite to the course, and the air would thus follow the earth like a long tail, as is seen with comets. Let the tail of the comet consist of whatever it may, we have to look upon it as an atmosphere of those puzzling bodies; and their atmosphere must stay back, tail-like, as they move on through the universe.

Finally, we desire to return once more to the consideration of attraction, in order to prove that the combination of the rotation of the earth upon itself and its revolution around the sun is an impossibility. When we spoke of the now-accepted theory of a revolution of the earth, we demonstrated that according to it the direction of gravity of the earth would have to change every moment. Again, in order for the sun to keep our earth in its course the direction of the gravity would each time have to go to the point of the surface of the earth which was nearest to the sun, and upon which therefore the centripetal force of the sun would work directly. Towards this point, therefore, the gravity of the earth must necessarily press (just as the centre of gravitation of the moon necessarily lies in the centre of the side which is constantly facing us), and all loose bodies would inevitably hasten towards it. But, according to our observations, this is not so. The centre of gravity of the earth is evidently in its centre, and hence it depends upon its own mass, without an outside force like the attraction of the sun working upon it. Is this not a convincing argument: first, that the earth is not kept on its course by an attraction of the sun, because this mighty attraction could not take place without changing the earth's centre of gravity; and second, that since the centre of the earth, untouched by any outside influence, is at the same time its centre of gravity, on this account this centre of gravity must be accepted as being the centre of the entire visible creation?

I am far from denying absolutely that the sun, or the moon even, exerts a certain attracting force upon the earth; but I believe I may assume with positiveness that this attracting force is too insignificant to exert any influence upon the rigid portion of our earth, but is confined as to its effect to the liquid bodies—mainly the air. Now since the attractive force of the sun is so inconsiderable that it can exert an influence only upon the liquid bodies, and that always insignificant, it is evident that it is much too slight to keep the earth in a circular course, if working as centripetal force. Such an immense force of attraction as would be required to keep the earth in its course around the sun, would long since have drawn the atmosphere away from the earth to the sun—as similarly, on the other hand, the earth would quickly attract any atmosphere formed on the moon.*

Let us now consider what revolutions in the total realm of astronomy would be created by acceptance of my assertion that the earth stands still in the centre of the universe. Though radical, such revolutions are yet comparatively insignificant. They consist simply in accepting as real the

* Astronomers have long recognized that the Moon is devoid of an atmosphere.

apparent movement of the celestial bodies which are to-day considered fictitious. This was done by Tycho de Brahe who, in my opinion, was the greatest of all astronomers. He claimed that the earth remains immovable in the centre of the world, the entire heavens revolving around it in twenty-four hours, with the moon, as well as the sun, by means of motions of their own, describing separate circles around the earth, just as Mercury and the other planets were describing epicycles.

Consequently, material points in astronomy are not altered, since it remains the same with the different calculations, whether we explain the local changes of the stars by a rotation of the earth, or by a rotation of the starred firmament. But many immaterial theories are dissolved into dreams.

In the first place, we have to abandon the opinion that the so-called fixed stars are suns, and the so-called planets bodies like our earth; for the calculations by means of which the mass and size of the celestial bodies are thought to be determined are erroneous, being based upon wrong principles. For instance, the weight of the sun has been calculated by means of the force of the attraction which it was thought to exert upon the planets. If now, however, the sun is no longer the ruling star, but fettered instead by the force of attraction of the earth, turns about the latter, then naturally that calculation must have been erroneous.

Moreover, they started from a wrong principle in calculating the size of the celestial bodies. It is a known phenomenon that the further off bodies are, the smaller they look upon our globe. An object distant 5,000 times its own diameter can no longer be seen by the human eye. According to this law the size of the celestial bodies was calculated. From their apparent size and their distance it was calculated how many times their real size must surpass their apparent size. But one thing was forgotten—namely, the important circumstance that the law according to which objects appear smaller in proportion to their distance cannot be applied to shining bodies. The stronger is the light of a shining body, the further it can be seen in unchanged size. I have stated that a body becomes invisible if the distance amounts to 5,000 times its diameter. If this law held good for the shining bodies, then a light with a diameter of 1-inch could no longer be seen at a distance of 225 steps. But it may be seen, in unchanged size, a distance of some odd thousand steps!

The shining of the sun being very intense, the sun must also be visible in its actual size at an immense distance, and it is very readily possible that it is not much larger than it appears to our eyes! Furthermore, it is not only possible, but very probable, that the law according to which bodies appear smaller the further distant they are, holds good only in our denser atmosphere. If, during a clear cold night, the vapors of the air are precipitated, and the sun rises and lights up the air, free from vapors, we then see mountains, regions, places (which at other times we see only in the blue distance) so greatly magnified as to appear nearer, while we are able to dis-

tinguish them exactly. The laws of refraction are conspicuously altered. What if they cannot be applied to the ether, or—should we prefer, in place of ether, to postulate empty space—to that empty space? I know this much from experience: the doctrine of visual angles is not at all absolutely correct, but the greater or lesser purity of the atmosphere must be taken into consideration.

The calculations which have been based upon moon-eclipses I shall not accept as correct so long as it cannot be demonstrated to me that the laws of the refraction of the rays of light apply to space. In reference to the fixed stars, it is not impossible that the calculations have been made erroneously. Moreover, the entire calculations of their distances are reduced to nothing as soon as we look upon the earth as stationary. According to the current theory, on December 21 the earth stands 40,000,000 of miles away from the point where it stands on June 21, while yet a star which you have seen through the telescope culminating on December 21, you will see through the same telescope on June 21 culminating on the same spot of the firmament! That distance of 40,000,000 of miles would consequently be nothing compared with the distance of the star observed. But this calculation of distance becomes void as soon as we return to the belief in the stability of the earth.

Permit me, gentlemen, to call your attention to another contradiction which ought long ago to have shown the erroneousness of the astronomical calculations. Calculating the supposed force of attraction exerted by the sun, it was found that a body exhibiting a pressure of one pound on our earth would exhibit a pressure of 27 pounds on the sun. If all bodies on the sun exhibit a weight so much greater than on the earth, the entire mass of the sun must be pressed together with commensurate force, and must consist of much denser matter. And yet, upon comparing the calculated weight of the sun with its calculated volume, it was found that the sun's matter was surpassed four times in density by the matter the earth consists of! According to this, the bodies on the sun are 27 times heavier than they would be on the earth, while yet this weight exhibits 108 times less energy than on the earth, the sun's density being one-fourth the density of the earth! I cannot understand this. I can only look upon these figures as results of calculations based upon false principles.

I must also deny that the planets have atmospheres. A celestial body, rushing with immense velocity through space, cannot have an atmosphere similar to that of our earth. The moon, the nature of which we know best, here again gives us the answer, or rather confirms what I have reasoned out from the general laws of nature: the moon has no atmosphere. Neither can the other stars have any; and the observations which are to demonstrate the existence of atmospheres are surely based upon an error. To make observations of this kind with any degree of security we would have to first lift

ourselves above our own atmosphere, and to erect our observatories at least on the summit of the Dhawalagiri.

Furthermore, the bodies of the sun, the moon and the planets cannot bear any resemblance to the earth in their surfaces, but must consist of matters closely combined with each other, as we see also from the meteorites now and then falling upon the earth. Loose matters, earth and stones on their surfaces, would be attracted by the force of the attraction of the earth and be dragged towards it. The hypothesis of a habitableness of these bodies must be dumped into the realm of dreams, on account of the various reasons given.

How we came to entertain the present astronomical ideas is now clearly demonstrated. We naturally supposed that the Creator must have placed the stars at a considerable distance in order to light up very large portions of the earth's sphere at the same time. Man calculated the distances of stars which were most important to us, calculated the sizes of the stars from these distances by wrongly-applied laws of reduction, stood astonished before these sizes, and was compelled to look upon the numberless fixed stars as just so many suns, and upon our earth as a minute particle of the universe. It was a logical consequence that it should seem to him contrary to reason to consider these mighty celestial bodies as circling around the earth, and as having evidently to thank the earth for their existence. And thus man came to the conclusion that the earth must be the rotating and revolving body, moving around the sun. And man went on and on, building upon this conclusion, connecting correct calculations with fantastic dreams.

I close my lecture, although it would be very easy for me to point out numerous other contradictions to be found in the present suppositions.

I wish that an astronomer, equipped with more perfect knowledge and modern instruments, would continue developing the system of Tycho de Brahe. The final result would certainly be grand, and many a thing would appear simple and clear that became dark after the advent of the Copernican system, contradicting all the laws of nature which we know. The esteemed astronomer, Bandes, has already said of Tycho's system: "This system seems to have more truth in itself—nay, the single phenomena may be demonstrated very easily with it." He means, however, that it contradicts the laws of attraction. This objection, however, I believe I have done away with, and have clearly shown that the Copernican system itself is in direct opposition to the laws of attraction.

It has not been the author's intention to present a complete theory in this lecture. He confesses his inability for it, and desired only to give impulse to new investigations. But he thinks himself entitled to the hope that some astronomer will at least free himself from cold superciliousness and go on building upon the basis given. For such a sincere scholar I add here a few out of the number of rich data which have been carelessly disregarded.

1. The forms of our continents contradict the hypothesis of the rotation of the earth. Were there such a rotation, these formations would have been built up in the main directions, from east to west ; whereas, in reality, we find their longitudinal development from north to south. Again, the larger latitudes of the north only point to the attractive force of the north [magnetic] pole, the points looking southward indicating the repulsive power of the south [magnetic] pole.

2. That there are no fixed stars proper has been demonstrated by the peculiar orbital motions which those fixed stars have in addition to their daily course about the earth. The astronomers have therefore sought in vain for a central body, the attraction of which would keep those stars in their course. But there must be such a central body, and it must be our earth. It may also result from this that, corresponding to the greater formation of continents upon the northern hemisphere, the greater number of stars is found on the northern half of the heavens.

3. Various changes have been observed in many of the fixed stars, especially a change of colors and of intensity of light (a sudden coming, and a going as sudden, of single stars), which cannot be brought into harmony with the supposition that they are such large and independent bodies as has hitherto been believed.

4. The uniformities of the parts of all meteorites—*i. e.*, of heavenly bodies dragged to the earth by its attraction—allows us a conclusion upon the nature of celestial bodies in general, and demonstrates that they cannot be habitable. The greatest meteorites of which we know had a diameter of from 7 to $7\frac{1}{2}$ feet.

5. According to Wilhelm Mahlmann's careful calculation, there is an air-current west-south-west, prevailing in the middle latitudes of the temperate zone ; hence there are, after all, prevailing west winds, whereas east winds should prevail, upon the theory of the rotation of the earth.

6. As my next treatise is to bring out the evidence that the Mosaic version of the creation harmonizes with the truth, and as the only objection made to me as yet respecting the rotation of the earth is the pretended agreement of the learned, I therefore quote here in conclusion a few words of Goethe. This poet, whose prophetic glances into nature were completely disregarded during his lifetime, says :

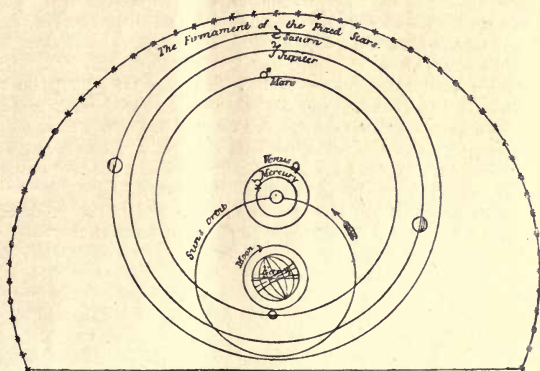
“Be it as it may, it must be laid down that I curse the accursed lumber-room of this modern conception ; and certainly some young, ingenious man will arise who has the courage to oppose this universal, crazy nonsense. The repeated assurance which all natural philosophers have had in this same conviction is the most outrageous thing you can hear. He, however, who knows men knows how this happens. Good, able, keen brains make up such an opinion on the basis of probability ; they assembly proselytes and disciples ; such a mass gains literary power ; one magnifies the opinion, exaggerates it, and carries it out with a certain passionate excitement ; hundreds and

hundreds of well-thinking normal men, who are active in other branches and also wish to see lively working in their surroundings, honored and respected—what can they do better and wiser than to give these ample scope, and to consent to what is not their business? And this is then called general agreement of scholars!"

THE BIBLICAL-TYCHONIC

vs.

THE NEWTONIAN-COPERNICAN SYSTEM.



TYCHONIC SYSTEM OR THEORY.

General JOHN WATTS DE PEYSTER,
Rose Hill, Red Hook Township, Dutchess Co.
Tivoli P. O., New York.

MY DEAR GENERAL:

The lecture of the German, Dr. Schoepffer, which you have obtained from abroad and of which you propose to print an English translation, certainly is remarkable. This assault upon the Copernican and Newtonian theories was originally delivered and published in 1854. Since that time a small army of astronomers diligently have prosecuted investigation to perfect the accepted hypothesis. Therefore we naturally expect Dr. Schoepffer's arguments to appear peurile in the light of present knowledge, even if they seemed plaus-

ible half a century ago. But, strange to say, instead of a development of facts which renders Dr. Schoepffer's position ridiculous, the new data in nearly every instance tend to justify his skepticism. His main arguments, formidable as they stand, and hitherto unanswered, may now be notably fortified, while many new counts may be added to his strong indictment of the current theory.

As you know, ere I had heard of Dr. Schoepffer, his lecture, or his views, I had become a confirmed skeptic concerning the supposed infallibility of Newton's demonstration of the Copernican theory, and indeed had lost all confidence in the truth of the Copernican hypothesis. Having been transformed from a religious agnostic of the hostile type into a believer in the verbal inspiration of Scripture, I was led to examine astronomical theories by the insinuation of certain rabid "scientists" on the one hand, and of certain "higher critics" on the other, that the astronomical theories of the Bible and of modern science were irreconcilable, while infallibility here certainly lay with modern science, demonstrating the fallibility of Scripture as a guide on such a point at least.

From a careful study of the Bible I ascertained the following facts: (1) That the Old Testament and the New Testament alike teach by inference, with some dogmatic statements on the subject, a certain astronomical scheme; (2) That *all* Biblical references to astronomical facts are undeviatingly consistent in implying this astronomical system and no other; (3) That any person left to gather his astronomical ideas from the Bible alone would necessarily imbibe a belief in this particular scheme; (4) That the Biblical system treats the phenomenal, or apparent, movements of the heavenly bodies as the actual movements of those bodies; (5) That the Bible represents the physical universe as having been definitely designed by God as a revelation of Himself and His ways by means of object-lessons; and (6) That in all instances of Scriptural reference to the heavenly bodies or the earth, as physical types of moral truths, the object-lesson is ever found in the phenomenal appearance of things, Scripture citing the phenomenal appearance as the physical fact.

And is this astronomical scheme of Scripture crude and primitive? So one would imagine from the cheap learning everywhere abounding which sweeps the Bible aside, with a magnificent flourish of intellectual superiority over Christian faith, on the ground that its fallibility is fully exposed in its astronomy! But what is the fact? Even the Ptolemaic theory of the universal mechanism has been justly commended for its ingenuity in explaining observed phenomena, while the Biblical system is infinitely superior to that perfected by Ptolemy and his followers, judged in the light of present knowledge. I say "infinitely" superior because Ptolemy's scheme, ingenious as it is, is absolutely inadmissible in the light of the facts now known, while all astronomers are compelled to admit that the system implied in Scripture accounts for all the observed phenomena as competently as does the Coper-

nican hypothesis. In other words, Scripture assumes the truth of the so-called Tychonic conception of the physical universe.

The scheme of Tycho Brahe rejects the postulates of the daily rotation of the earth upon its axis and of its annual revolution about the sun, making the earth the stationary centre of the physical universe. He accepted as real the apparent daily revolutions of sun, moon and star-sphere about the earth, the sun also having an annual movement in the heavens between the celestial tropics, causing the changing seasons. The planetary movements were accounted for as in the Copernican system—the planets moving in orbits about the sun, the orbits of Venus and Mercury passing between the sun and earth, the orbits of the other planets passing outside the space between the sun and the earth, the radii of the orbits of these outer planets much exceeding the distance between the sun and the earth.

"All the observed movements, and all the peculiarities of the observed relations, were fully explained by this system," wrote the late Prof. R. A. Proctor, who was perhaps the most dogmatic champion of Newtonian-Copernican orthodoxy among astronomers of standing, as well as the most virulent in applying it to discredit the Bible.* In the same connection he further wrote: "It is not too much to say that Tycho's system is . . . fully equal to the Copernican in its fitness to explain the observed relations."† And he added that, until the probabilities in favor of the Copernican theory were strengthened by Newton's hypothesis of universal attraction, "the arguments for the Tychonic system, modified so as to correspond to Kepler's discovery of the shapes of the different orbits, were almost equal in weight to those used by the disciples of Copernicus. The slight advantage of the Copernican system in point of simplicity was counterbalanced by the difficulty of accepting, in those days, the belief that the stars lie at so inconceivably vast a distance that the motion of the earth in an enormous orbit around the sun (for the sun was known even then to lie many millions of miles from us) produces no perceptible change in the appearance and rotation of the star-sphere. That the whole span of the earth's orbit [now computed as 186,000,000 miles] was as a mere point compared with the distance of the stars, so that the earth on one side of the sun was, in effect, at the centre of the star-sphere, while it was equally at the centre when on the opposite side, or many millions of miles from the former position, was not unreasonably regarded by Tycho Brahe as scarcely credible."‡

In almost every reliable treatise on astronomy can be found a similar acknowledgment of the adequacy of the Tychonic system, and hence of that of the Bible. How fully "equal in weight" to the arguments for the Copernican theory were those for the Tychonic theory is well demonstrated by the fact that in the presence of the arguments on both sides the Copernican

* Article, "Astronomy." Encyclopædia Britannica, 9th ed., vol. ii., pp. 777-8.

† *Ibid.*

‡ *Ibid.*

theory had few supporters among the best intellects, down to the time when the astronomical priestcraft dogmatically prohibited dissent, for all who were unwilling to imperil their reputation for sanity, by the Newtonian assumption of an infallible mathematical demonstration which neither ordinary laymen nor even the majority of scholars were capable of testing for themselves.

But, however this may be, we here have the virtual confession even of so rabid a disciple of Copernicus as Professor Proctor, that it is Newton's postulate of universal attraction which alone has given the Copernican theory a greatly preponderating claim upon our credence. Hence, if it should finally transpire that the Copernican theory must stand without the help of Newton's theory, if at all, even so rabid a disciple of Copernicus as Professor Proctor would have justified us in turning back to consider seriously the Tychonic theory, as one in favor of which, on the confession even of its opponents, nearly as much can be said as may be said for the Copernican theory! And if a disciple of Copernicus must admit so much in favor of the rival view at the outset, what might not a disciple of Tycho, and still more a student of scripture, discover in favor of the Biblical view? But will it be said that there is little likelihood that the Copernican theory will be forced to establish its claims on some other basis than the postulate of universal gravitation? In reply, I present the following points:

I. Some of the best mathematical astronomers are beginning to deny that Newton's law of gravitation is a real mathematical expression of the attractive forces of nature. For example, G. W. Myers, of the University of Illinois, contributes to *Popular Astronomy* (January, 1898) an English translation of the interesting paper "On Newton's Law of Gravitation" by Prof. H. Seeliger, of Munich, Germany, in which this fatal defect in Newton's law is conceded. This paper was originally published in the "Proceedings of the Bavarian Academy," November, 1897. The kernel of Dr. Seeliger's criticism is found in the following extract from Mr. Myers' translation:

"About two years ago [in 'Ueber das Newton'sche Gravitation-Gesetz'] I drew attention to certain difficulties arising out of the attempt to extend Newton's law of gravitation to infinite space. The considerations then adduced showed the necessity of choosing between two hypotheses, viz.: 1. The sum total of the masses of the universe is infinitely great, in which case Newton's law cannot be regarded as a mathematically exact expression for the attractive forces in operation. 2. The Newtonian law is rigorously exact, in which case the infinite spaces of the universe cannot be filled with matter of finite density. Inasmuch as I am wholly unable to find adequate reasons for the second of these assumptions, I have, in another place, decided in favor of the first. Since reaching this conclusion, it has come to my knowledge that Carl Neumann ['Allgemeine Untersuchungen ueber das Newton'sche Prinzip,' &c., Leipzig, 1896, p. 1] had called attention still

earlier to difficulties of a similar kind which may be regarded, in a sense, as special cases of the arguments I brought forward. The concurrence of so prominent a scientist, as also the circumstance that the considerations adduced by myself are expressible in another form without essential modification of their contents, may perhaps make a return to this subject seem superfluous. But it appears to me the entire question is so fraught with significance for the whole of theoretical astronomy as to merit thorough-going and perspicuous treatment. . . .

"The problem under treatment has some points of resemblance to another well-known question. Cheseaux, and after him Olbers, propounded the question as to why the average brightness of the celestial vault is so very small, whereas it should be comparable with solar brightness, if the number of luminous bodies in the universe be assumed infinitely large. It seems all the more desirable to treat this problem more fundamentally than was formerly done, since, by so doing, it appears that Olbers' conclusions [in support of current theory] are far from being entirely free from objection. Olbers explains the seeming paradox, as is well known, by the extinction of light in interstellar spaces. The permissibility of this assumption cannot of course be contested [?]; its necessity, however, does not by any means follow from an unbiased study of the question."

II. Professor Seeliger, according to Mr. Myers' translation, gives Professor Neumann's reduction of Newton's law to an absurdity in the premises at issue, concluding with the remark:

"This is the example which Carl Neumann adduces. He correctly designates the demonstrated consequence of Newton's law as absurd, and concludes from it that the law of attraction leads to contradictions in the case of an homogenous distribution of matter."

Thus, according to these authorities, Newton's law of gravitation is irreconcilable with the theory of the existence of a substantial ether in space and between the molecules of bodies—an all-pervading ether consisting of the ultimate atoms of matter. But a hopeless clash here necessitates the abandonment of the doctrine of universal attraction, under the peril of utterly wrecking the basis of theory underlying every ramification of the existing structure of physical science. For example, how is the scientist to conceive of radiant energy manifesting itself in space as heat, light, chemical force and electrical force, if there be not an all-pervading substantial medium to be operated upon? How are we to explain the now all-important doctrine of the conservation of energy, if there be not everywhere the medium to receive and transmit kinetic energy?

III. The dynamical theory of matter (though I do not commit myself to it, being an agnostic on most of these questions, where not an open sceptic) certainly seems far more rational, as the basic explanation of physical phenomena, than the theory of universal attraction, as lending itself equally to the explanation of all the manifestations of radiant energy where these

phenomena exist, and to the phenomenon of attraction where this exists; while to an unprejudiced mind the dynamical theory of matter, as formulated by Lord Kelvin, seems utterly irreconcilable with the theory of universal attraction. For can we conceive of the ultimate atoms as a vortex-movement everywhere in space, with the freedom for this, and at the same time conceive of this as the result of a universal law of mutual attraction? Or, if universal gravitation be not applied to the ultimate atoms, it were more rational to throw this awkward hypothesis aside as useless lumber, and substitute for it the theory of radiant energy, joining together the phenomena of attraction and repulsion, with heat, light, chemical force and electrical force, as all alike resultants of radiant energy.

IV. Spite of the herculean efforts in the domain of mathematical, or theoretical astronomy, Professor Asaph Hall, the well-known American astronomer, who enjoys the distinction of having discovered the two satellites of Mars, also concedes the inability of astronomers at the present time to account for all the observed phenomena on the basis of Newtonian hypothesis. He further concedes that many of the problems which in the first half of the present century were thought to have been mathematically solved on the basis of Newton's postulate, are now proved not to have been so—which is a concession that the claim of the attainment of mathematical infallibility, imposed upon the public by astronomers during the first half of the century, was really an audacious assumption, raised upon foundations many of which have already crumbled! He says:

"Laplace devoted his life to the study of celestial mechanics. In his great work on this subject he undertook the solution of all the problems connected with the theory of the planets. Their motions are divided naturally into two parts. Some of the changes are periodical, and the planets return after a few years to their former positions. But others run through long periods of time; and these changes produce great alterations in the orbits. Such are the great variations in the eccentricity of the earth's orbit, and obliquity of the ecliptic, which are thought by some to have been the cause of the glacial epoch on the surface of the earth. These changes are very important. They were carefully examined by Lagrange and Laplace, who proved, as they thought, that our solar system is stable, and that the great secular changes will come and go through very long intervals of time, amounting to tens and even hundreds of thousands of years, but that the orbits will again come back to their former shapes and positions. Seventy years ago, when Laplace died in 1827, it was thought by many astronomers that nothing remained to be done in celestial mechanics but to correct the coefficients in the formulas of the '*Mechanique Celeste*.' But the passing years have changed all that, and parts of theory have to be worked over anew. . . .

"Laplace undertook to show how the arrangement of the Creator might be improved. He says: 'If at the origin the Moon had been placed in

opposition to the Sun, and at nearly four times its present distance, and the Earth and Moon had been started with parallel motions proportional to their distances from the Sun, the Moon would always have remained a full Moon, and thus would have replaced the light of the Sun.' Unfortunately for Laplace the condition he has imagined is unstable, and at the slightest disturbance we should have lost our Moon. We are tempted to apply to Laplace one of his own mottoes: '*Opinionem commenta delet dies, natura judicia confirmat*'—'Time destroys the fictions of opinion, and confirms the decisions of nature.'

"Time, in fact, which tests all things so severely, has shown that some of the results of theoretical astronomy are erroneous, and that others must be extended and completed. Thus the stability of our solar system was not proved, as was supposed, and although it would be wrong to call it unstable, yet the mathematical proofs given by Lagrange, Laplace and Poisson are not complete. Also the very important part of the changes of our solar system which are called secular, because they run through long periods of time, need to be examined again. With our present formulas we can not go backward or forward from our epoch with certainty for more than a few centuries, and the improvement of these methods is an important and difficult question. The Swedish astronomer, Hugo Glydén, who died a few months ago, was engaged on this problem.

"But there is another source of difficulty in the planetary motions which the lapse of time is developing. While the Newtonian law of universal attraction represents the observations so well that it must be a real law of nature, yet there are indications of small forces which cause deviations from the principal force. Evidence of such a force is seen in the formation of the tails of comets when they approach the sun, since the particles appear to be thrown off by a repulsive force, and we have here a new condition. There is also the question of a resisting medium in the planetary spaces. For many years it was thought that the existence of such a medium was shown by the motion of Encke's comet, but recent investigations have pretty much overthrown this idea, since the change in the orbit of the comet does not correspond to an acceleration of the motion, such as would result from a resisting medium. We are thrown back, therefore, on an unknown cause to account for these changes. The motion of our moon has been the subject of some of the most laborious researches ever undertaken in astronomy. The moon's motion is so rapid that any inaccuracy in its theory will soon appear. A good knowledge of this motion is closely connected with the art of navigation, and the English government has expended large sums of money to perfect the lunar tables. But the last tables, computed by Hansen forty years ago, are now so much in error that it is necessary to correct them by an empirical method, since no defect has been found in theory. Delaunay devoted fifteen years of steady work to the motion of the moon, and produced the best theory we have; but the puzzling thing is that he agrees remarkably well with Han-

sen, who pursued a very different method, and is certainly wrong. There is another theoretical mystery. Another disturbance of this kind was found by Leverrier forty years ago in the motion of the planet Mercury, and his result has been confirmed by the recent investigations of Professor Newcomb. The major axis of this planet is moving faster than it ought from the action of the known forces. In this case it is very certain there is no defect in the theory, and we are obliged to search for a force that can produce this motion." *

V. The explanation of such remarkable language is involved in my next count. Why is it that, in the presence of the discrepancies which he points out, the best reason Professor Hall can give for still accepting the Newtonian law is the surprisingly weak one that "the Newtonian law of universal attraction represents the observations so well that it must be a real law of nature?" Because he is too well aware that this Newtonian representation of the observations has been approximated on a basis which could not be considered a mathematical demonstration of the operation of *gravitation*, even were it a perfect success, and no discrepancies in sight! In other words, had Laplace been so permanently successful as he supposed and hoped, the question would remain whether Newton's law had been adjusted to the real facts of nature, or whether supposed conditions in nature had not been in many cases "assumed" to fit the requirements of theory; and, if this last were not the case, the question would remain whether Newton's law is the mathematical expression of gravitation or of some other force in nature which actually performs the work in the solar system credited to gravitation.

What was the situation when Newton undertook his solution of celestial mechanics? Tycho Brahe had amassed a record of observations which presented nearly all the main phenomena to be accounted for, from which Kepler had surmised the fact that the planetary orbits are elliptical, and had deduced his three laws of planetary movement. Galileo had formulated his two laws of motion, having investigated the phenomena of falling bodies at the earth's surface. It now occurred to Newton that the attraction of the earth might be a local manifestation of a universal phenomenon, which would thus be the controlling principle of the solar system; and he undertook to demonstrate the possibility that the laws of falling bodies at the earth's surface might explain the celestial phenomena. To this end he formulated his very convenient law of motion—that action and reaction are equal and in opposite directions—which to an ingenious mind would afford ways of escape in the presence of almost any conceivable phenomena. The problem before him was this: Could he, by assuming for the respective heavenly bodies any distances, sizes, densities, masses and velocities convenient for his purpose, that were not demonstrably inappropriate to the observed phenomena, show

* "A Sketch of Theoretical Astronomy." *Popular Astronomy*, May, 1897 (Vol. V., No. 1., pp. 9-16).

that the application of the laws of falling bodies at the earth's surface would approximately explain the planetary movements and similar celestial phenomena? I do not mean to undervalue the difficulties of this problem. Even with the privilege of adjusting so many elements of the problem to suit the theory, the complicated elements of observed phenomena which could not be so adjusted were so formidable that it remained a stupendous undertaking in higher mathematics, so that the "*Mechanique Celeste*," in which La Place systematized the results of the mathematical labors of himself and his predecessors, is perhaps the most remarkable monument which the human reason has ever erected as an evidence of its powers. Still, the fact remains that had time disclosed no discrepancies and inadequacies in this solution, when compared with the present records of observations, it yet would constitute only a *possible* solution, and not a mathematical demonstration, until such time as the assumptions of distances, sizes, densities, masses and velocities in the solution could by some independent means be demonstrated as really those of nature. And were this done, there would still be a possibility that the mathematical formula was really that of some unknown force, instead of gravitation.

But have astronomers made this plain to the general public? An examination of treatises rather exhibits a studious avoidance of frankness here, while the intent to deceive the ignorant certainly *appears* to characterize some works, which yet do not technically commit themselves. It is this fact which justifies one in speaking of an astronomical priestcraft, which has acquired a reputation for scientific infallibility and an authority over the human mind which have no justification in actual achievements. As a matter of fact, excepting mathematical astronomers themselves, even the most learned among men for the most part necessarily rest their belief in the current astronomical theory, together with whatever system of philosophy of life they build up from this foundation, upon a confidence in the infallibility of professional astronomers as blind and helpless as that of the most infatuated religious devotee in the priestcraft which gives him a false religion. Indeed, one reason why scientists now speak so plainly and unguardedly to one another of the shortcomings of theory, through the medium of books and periodicals accessible to the general public, seems to be their sense of perfect security—the feeling that the battle has been won, with the popular submission to "science" so far advanced that there is no fear of a revolt, even when the Quaker guns which have won the victory are plainly unmasked! Is such a remark unjust? To justify it I need but marshal another extract from the very article of Professor Asaph Hall just cited; for his introductory remarks include the following:

"Theoretical astronomy has gained so secure a foundation, and its results are so generally accepted, that the trials and tribulations of astronomers are matters of the past. They can now look on in quietness, and with complacency, while theologians charge each other with heresies. . . . This change

has been firmly established by the discovery of the law which governs the motions of the heavenly bodies." *

Are these introductory remarks Professor Hall's justification to his fellow astronomers, in view of his temerity in discussing the deficiencies of astronomical orthodoxy in a tongue within the comprehension of laymen? Yet even if he does not fear, one would suppose he would at least blush for his profession, in thus exposing to the public the weakness of astronomical pretensions on the very point in virtue of which astronomers have lifted themselves into Moses' seat of authority and infallibility! A similar temerity, displayed in frank expression of weakness in the presence of the subdued enemy, characterizes Professor Karl Pearson's well-known "Grammar of Science." The passage is worth quoting here, and especially so as any reader of the book can testify with what an animus its author recommends for study, as examples of sophistry, famous books which argue the reasonableness of supernatural religion:

"No one who knows the author's views, or who reads, indeed, this book, will believe that he holds the labor of the great scientists or the mission of modern science to be of small account. If the reader finds the opinions of physicists of world-wide reputation, and the current definitions of physical concepts called into question, he must not attribute this to a purely sceptical spirit in the author. He accepts almost without reserve the great results of modern physics; it is the language in which these results are stated that he believes needs reconsideration. This reconsideration is the more urgent because the language of physics is widely used in all branches of biological (including sociological) science. The obscurity which envelops the *principia* of science is not only due to an historical evolution marked by the authority of great names, but to the fact that science, as long as it had to carry on a difficult warfare with metaphysics and dogma, like a skillful general conceived it best to hide its own deficient organization. There can be small doubt, however, that this deficient organization will not only in time be perceived by the enemy, but that it has already had a very discouraging influence both on scientific recruits and on intelligent laymen. Anything more hopelessly illogical than the statements with regard to force and matter current in elementary text-books of science, it is difficult to imagine." †

If this amazing confession of scientific jesuitism had come as a charge from me, I suppose I should have been denounced as a rank traducer!

At this point I will suspend the cataloguing of objections to the Newtonian theory, in order to show the plausibility of the Biblical-Tychonic theory, that the reader may realize how rational an alternative is offered him. Already it is apparent, on the testimony of eminent disciples of Copernicus

* *Ibid.*

† "Grammar of Science." New York: Charles Scribner's Sons. 1892. Pp. vii., viii.

and Newton, that (1) the Tychonic theory is in itself as competent, and very nearly as credible as the Copernican theory, in itself, or when considered apart from the support of the Newtonian hypothesis; while (2) there are the gravest reasons for doubting whether the Newtonian postulate of universal attraction can very much longer support itself—not to speak of rendering aid to the older hypothesis. Hence, on these grounds alone, without going any further, it is evident that one might very rationally consider the authority of the Bible preponderating evidence in so close a decision, and so reject Newtonian-Copernican theory in favor of the Biblical-Tychonic system; while the branding of such a decision as preposterous or unscientific would only be possible to the ignorant masses, blinded by popular error as to the real facts of the case, and betrayed by an absurd confidence in the infallibility of astronomical orthodoxy!

But I shall also show that there are most positive and rational reasons for embracing the Biblical-Tychonic theory. I will show that if the new facts of science have been undermining and discrediting confidence in Newtonian theory, as a competent explanation of the hypothetical Copernican mechanism of the universe, at the very same time the new discoveries of science have been placing in our hands the most perfect and competent explanation of the Biblical-Tychonic mechanism of the universe, and one too which embraces in its explanation, as one connected system, the entire wide range of physical phenomena which has amazed modern scientists! Is this incredible? Let us proceed to the demonstration!

I mean by the Biblical-Tychonic system, the astronomical scheme suggested by Scripture. The Bible, and not Tycho Brahe, is the authority I believe in and have ventured to follow, while Tycho's merit for me lies in the fact that his most rational and competent system is the one whose essential elements the Bible sustains. The Biblical scheme may be briefly outlined as follows:

1. The physical heavens and earth stand in a relation which adumbrates the moral relation subsisting between the scene of God's presence and the scene of man's activities. This moral relation is summarized in the statement: "The heavens are My throne, and the earth is My footstool" (Isa., lxvi. 1); the first being characterized as the source of Creator-dominion and government, as well as the source of blessings, goodness and mercy for the creature; while the earth is characteristically the theatre of God's display of His attributes before all creation, and the scene of the execution of His counsels in view of eternity—the passive and unworthy recipient of heaven's bounty.

2. The physical relation answering to this moral relation is announced in the opening verse of the Bible: "In the beginning God created the heavens and the earth."

3. Scripture indicates a considerable period between this original creation of the heavens and the earth, and the adjustment of the physical universe

immediately prior to the creation of the first human inhabitant of earth. For, in Gen. i. 1, an original creation of the heavens and the earth is announced; in Isa. xlv. 18, Heb., we are told of "God Himself who formed the earth and made it, He who established it," that "*not* as waste did He create it;" while in Gen. i. 2, we find that the earth had become "waste and empty," with "darkness on the face of the deep." Thus between this original creation and this chaos occurred the geological ages, with we know not what celestial phenomena; while this long period (for such it was, unless geological science utterly deceives us) was terminated by some cataclysm which certainly embraced our present solar system.

4. Out of this chaos, by His fiat, God reconstructed in six days the solar system substantially as known to us; peopled earth, air and water with terrestrial animal and vegetable life; and created the first human pair. On the first day He invoked light where there had been darkness; on the second day He separated atmospheric heavens from the floods; on the third day he caused portions of the submerged earth's surface to emerge from the floods, and gathered the waters in sea-beds; and on the fourth day He established "light-bearers" in the expanse of the heavens—sun, moon and stars.

5. Thus the earth is the centre of the physical universe—the special object of the offices of the various celestial bodies.

6. The earth is stationary, all thought of rotation on an axis or of annual revolution being dismissed by the language of Scripture, if taken literally. In fact, the earth is in Scripture everywhere the type and symbol of fixedness and stability. (The following passages will be found to be characteristic: I. Sam. ii. 8; Job ix. 6; xxvi. 7; xxxviii. 4-6; Ps. xlv. 2; lxxviii. 69; cii. 25; civ. 5; cxix. 89, 90; Prov. viii. 29; Isa. xlii. 13; xxiv. 18-20; li. 13; Mic. vi. 2; Zach. xii. 1; Matt. xxiv. 35; Heb. i. 10-12.)

7. In point of size the heavenly bodies are divided into two classes: "The two great lights," or sun and moon, and "the stars" (Gen. i. 16).

8. The sun is much larger than the moon, since of "the *two* great lights," the sun is distinguished as "the great light," and the moon as "the small light" (Gen. i. 16). This conception of relative sizes is also indicated by the Apostle Paul in I. Cor. xv. 41.

9. The "rising," "setting" and "going down" of the sun are constantly mentioned in Scripture, in the Old Testament and the New, thus implying the reality of the phenomenal appearance of the daily revolution of the sun about the earth. A good concordance will show how common are such phrases. Somewhat more definite reference to the daily movement of the sun is found in Josh. x., 12, 13; Hab. iii. 11; Ps. xix. 4-6; Ecc. i. 5; *

* In Eccl. i. 5-7 we have the following:

"The sun also riseth, and the sun goeth down, and hasteth to its place where it ariseth.

"The wind goeth towards the south, and turneth about towards the north; it turneth about continually, and the wind returneth again to its circuits.

"All the rivers run into the sea, yet the sea is not full; unto the place whence the

Isa. xxxviii. 8. Thus, in the records of the two notable miracles (Josh. x. 12, 13—cp. Hab. iii. 11, and Isa. xxxviii. 8), we have records of the actual physical phenomena, sun and moon being restrained in their daily courses about the earth in the one case, while in the other the sun was made to recede on its course. Josh. x. 12, 13 affords evidence of the daily revolution of the moon, as well as of that of the sun. The daily revolution of the star-sphere about the earth is necessarily assumed in this system.

10. The special office of the sun, moon and stars is to minister to the earth. These celestial bodies were ordained "to divide between the day and the night," "for signs, and for seasons, and for days and for years," and to "be for light-bearers in the expanse of the heavens to give light *on the earth*" (Gen. i. 14, 15). Again we have the very definite statement: "God set them in the expanse of the heavens, *to give light on the earth*, and to rule during the day and during the night, and to divide between the light and the darkness" (Gen. i. 17, 18; compare Ps. civ. 19, Jer. xxxi. 35, and many other passages).

11. The celestial bodies are physical types of the ministry of divine goodness from the moral heavens to man and his world.

a. The sun is a type of God in relation to the universe ("God is light"—I. John i. 5; cp. Eph. v. 8; "dwelling in unapproachable light"—I. Tim. vi. 16; cp. Ps. civ. 1, 2). It is especially a type of God the Son, Revealer of the glory of the Godhead—the Divine Person who has the office of visitation and ministration to the earth in a special and literal sense ("The Sun of righteousness shall arise, with healing in His wings"—Mal. iv. 2; cp. Ps. xix. 4-6; John i. 7-9; viii. 12; ix. 5; I. John ii. 8; Rev. xxi. 23).

b. I believe the moon is a type both of the nation of Israel and of the Church of Christ, when either is viewed as a collective unit; but this is not so readily demonstrated by a mere reference to proof-texts. It is in their character as ordained mediums of God's communication of the light of revelation to the earth, that Israel and the Church may each claim the moon as their symbol.

c. The stars are sometimes types of angelic ministry (Ileb. i. 7, 14; Rev. i. 16, 20), including fallen angels, under whom the administration of the affairs of this world has been left for a time (Dan. viii. 10; Rev. vi. 13; viii. 10-12; xii. 4; II. Cor. xi. 14). The stars are also types of individual saints, new-born from above, who are vessels of the communication of the light of truth to the men of earth (Dan. xii. 3; Matt. v. 14-16; Phil. ii.

rivers come, thither they return again" (see LXX.)

In verse 6 here we have exact science: the law of the trade-winds and counter-trade-winds between north pole and equator, as accurately stated as they could have been by the late Prof. M. F. Maury. In verse 7 we have exact science: a summary of the perpetual water-circuit on the earth's surface, maintained by streams flowing seaward, whose springs in turn are fed by the sea, through the process of evaporation, cloud formation and showers. May we interpret verse 5 as intended to convey something less reliable than the exact science found in the accompanying verses?

15, 16). A star is also several times used metaphorically of Christ (Num. xxiv. 17; Rev. ii. 28; xxii. 16; cp. Matt. ii. 2, 7, 9, 10).

This hurried review may convey a fair idea of the astronomical scheme of the Bible. The careful tuition which has nursed us in Newtonian-Copernican notions naturally inspires ridicule for this rival theory. But let us remember that surrender to any tendency in this direction is but the symptom that our minds are too narrow to appreciate the actual facts of the case—the testimony of the best experts that this Biblical scheme, which seems so crude to our present prejudices, shares equally with the dominant theory the ability to explain all the observed phenomena! Moreover, the mechanism of the Biblical-Tychonic system can now be explained on a most rational and plausible principle.

If a bar of soft iron be placed in the centre of a coil of wire and an electric current be sent around the wire, the iron will be transformed into a magnet, retaining its magnetism while the current passes. If steel is used instead of iron, the passing of the current about it transforms the steel into a permanent magnet. It is by means of electricity, thus applied, that the most powerful magnets are obtained. Let the earth be the stationary iron or steel bar in the centre, with the sun, by its daily and annual movements creating about it a constant and powerful electric current, and we have a principle which is remarkable for its simplicity, and yet seems capable of explaining, not merely the Biblical-Tychonic mechanism, but all the observed phenomena of the physical universe!

I. This principle would explain the phenomenon of terrestrial gravitation. It is a fact well known that the earth is literally a great magnet, with magnetic poles. The north magnetic pole is situated about 1,000 miles from the geographical or axial north pole, so-called—the existence of the latter being assumed by the postulate of the daily rotation of the earth upon its axis. The tendency of a magnet to arrange itself in the line of the magnetic meridian, or nearly north and south, is the principle on which the mariner's compass, with its magnetic needle, is constructed. On the assumption which we have made, terrestrial gravitation is simply a phenomenon of magnetism—the attractive force of that great magnet, the earth.

The law of terrestrial gravitation (determined from the investigation of falling bodies, joined with the assumption that we may regard the attractive force of the earth as if concentrated at its centre) seems to be, that the attraction of all bodies toward the earth varies as the product of their masses, and inversely as the square of the distance from the centre of the earth. Experiments with magnets are said to have disclosed the law that the magnetic force of attraction likewise varies inversely as the square of the distance. So far the facts strikingly favor the solution here proposed. But it is said that gravitation differs from magnetic attraction in virtue of the fact that gravitation is directly as the masses, without reference to the nature of these masses, whereas magnetic attraction takes into consideration the nature of

the masses. To account for this, however, we need only resort to the hypothesis of a primary and secondary effect (a favorite solution in modern physics), under the primary effect grouping all the phenomena of so-called gravitation, based on the fact that the earth is maintained as a stable magnet by the sun's electrical ministry, while under the secondary effect we may group the phenomena of ordinary magnetism and electricity, which vary with varying conditions.

Thus we also account for the fact that all substances are not magnetic, or attracted by a magnet, but that some are diamagnetic, being repelled by the magnet. The principle to be noted is that all bodies on the earth's surface are either magnetic or diamagnetic: nothing is indifferent to the magnet: whatever is not positively attracted by the magnet is positively repelled by it. Probably there is some relation between this phenomenon and the analogous one of the existence almost everywhere of either a positive or negative electrical state, while a body positively electrified repels another similarly charged, but attracts a body charged with negative electricity; and a body negatively electrified repels another similarly charged, but attracts a body charged with positive electricity. On the basis of this solution we would thus say, that the primary action of the earth as a magnet attracts all bodies within range of its influence, according to the fixed law controlling the action of falling bodies, while the secondary effects, exhibited in the phenomena of electricity and magnetism on the earth's surface, vary according to varying conditions and different substances, producing the phenomena of positive and negative electricity and of magnetic and diamagnetic conditions.

II. This solution of the Biblical-Tychonic mechanism of the universe also enables us to group together the phenomena of heat, light, actinic force or chemical energy, electricity, and magnetism, as simply different manifestations of the ultimate physical energy, which in view of its source and the power of diffusion, we may designate as *solar radiant energy*. The close relation between heat, light and chemical energy has been demonstrated. The potentiality of a ray of sunshine embraces them all, and in the refraction of such a ray by its passage through a prism, the majority of heat-rays are arranged below the light rays and the majority of actinic-rays are arranged above the light-rays, so that the heating energy of the refracted sunbeam is greatest below the color band and the chemical energy is greatest above the color-band. Again, the heat-rays have been concentrated, this increase of their refrangibility changing them into light; while by taking the chemical rays alone and passing them through certain solutions which decrease their refrangibility, they are similarly changed into color rays. Thus has apparently been established, not alone the intimate relation of heat, light and actinic energy, but their interconvertibility.

Again, the energy of a current of electricity may be converted into chemical energy, into heat, into light and into magnetism. The art of electroplating embodies the principle of producing chemical energy by means of

an electric current. The electric light, now so common, illustrates the conversion of electrical energy into luminous energy, while the conversion of electrical energy into heat is a necessary step in the more difficult process of conversion into light. On the other hand, heat can be converted into an electric current, as exemplified in the thermo-electric battery. We have already noticed that electrical energy can be converted into magnetic energy, a magnet being formed by passing a current of electricity about a piece of steel. Machines constructed on this principle are employed in commercial life. On the other hand, magnetic energy may be likewise converted into electrical energy, this principle being utilized in the dynamo-electric machines which generate the electric current for the production of the electric light of commerce.

Thus not alone is the Biblical-Tychonic conception most rational in making our sun the physical source of all energy in the physical universe (for it is only a Copernican imagination which can feel sure, in the absence of any real evidence, of the existence of energy beyond the range of the sun's power), but we are thus able to explain in a scientific manner the undoubted affinity existing between heat, light, actinic energy, electricity and magnetism. Their interconvertibility demonstrates that these phenomena are simply various manifestations of an ultimate energy: and what can this ultimate energy be but solar energy!

III. This solution of the Biblical-Tychonic scheme is also in most perfect harmony with the all-important law of the conservation of energy. The formulation of this law has been styled the greatest scientific achievement of the nineteenth century. The interconvertibility of physical forces, of which we have spoken, has suggested to scientists the postulate of some universal energy, of which these particular forces are but special conditions, modes or manifestations. Taking the so-called physical forces in what seems to be a convenient order of transformation, we have a circular chain which returns into itself as follows: heat produces light, light produces chemical action, chemical action produces electricity, electricity produces magnetism, magnetism produces mechanical motion, mechanical motion produces heat. Scientists have puzzled themselves over the postulate of some universal energy behind this circle. The Biblical-Tychonic hypothesis puts a period to this search by placing behind this circle of forces, as their source, one well-known agency—the sun. And all scientists must now concede that, barring the anomaly of universal attraction, this solution is practically correct for our own solar system; although their troublesome postulate of many solar systems forces them to search for some common unknown energy behind these many imaginary suns.

Taking as a basis this relation of the physical forces, disclosed by their interconvertibility, the law of the conservation of energy recognizes that the energy of the universe is never diminished, but is a constant quantity which is constantly undergoing transformation from one form to another,

performing in the process all the various phenomena of the physical world. This theory has the rational feature of necessitating the postulate of an Infinite Creator of the physical universe; for if the sum-total of energy in the universe is ever the same, either this condition must have existed from eternity, or else at some time the physical universe was launched by some great Power who endowed it with the potential energy which has since been in process of transformation into kinetic energy. But the physical universe could not have existed from eternity, because its energy is not infinite; for, had such a universe existed from eternity, its finite, fixed quantity of potential energy would long ago have assumed the kinetic form, and this would have diffused as heat, causing all matter to have a uniform temperature and terminating all motion and all life—which is not the case. Hence, the physical universe had a beginning; and since it was launched with the full endowment of its present energy as potential energy, it necessarily had a Creator and Endower, Who necessarily is greater and more powerful than His workmanship. It follows that the potential energy with which the physical universe was endowed, had existed as potential energy in the Person of this Creator from all eternity.

But the Biblical-Tychonic theory has the merit of permitting us to conceive of the law of the conservation of energy without the qualification of the corollary of the dissipation of energy. Let me explain this for the reader who may be unacquainted with the theory. By potential energy is meant energy in a passive or stored-up state, which by some means may be transformed into an active force. This becomes kinetic, actual, or active energy, when it is liberated as an acting power which is accomplishing results. Thus we have the potential energy of gravitation in a weight which is raised and suspended, while this becomes the kinetic energy which carries it to the earth when the weight is released. Potential chemical energy is stored in explosives, and becomes kinetic energy when released in their explosion. When a watch is wound up potential mechanical energy is stored in its main-spring, while the mechanism which gradually releases it converts it into kinetic energy, the watch "running down," as we say, when all the potential energy has been so utilized.

According to theory, if the mechanism of the universe were like that of a watch, and it had been wound up by the Creator, with the endowment of so much potential energy in the main-spring, then when all this potential energy had at last been utilized in the kinetic energy which produces the pulsations of nature, these pulsations would cease—the watch would be run down. But it is recognized that the universe is not, in fact, so constructed, but has been devised by an Intelligence who makes the given potential energy do much more work; for in the laboratory of nature much of the kinetic energy, after doing its work, is converted again into potential energy, and is thus ready to do more work. Now if *all* the kinetic energy could be converted back into potential energy, after doing its work, we would thus

have an endless circuit; the mechanism of the universe would be adjusted on the self-sufficient principle of perpetual motion, and the watch would never run down, however its movements might change, like the phases of a kaleidoscope. But, according to the current theory, neither is this the fact. All experiments seem to show that in this process of transformation, so as to make a continuous circuit of forces, there is a dissipation of energy into forms from which it cannot be recovered for further utilization in doing work. The experiments seem to show that if heat be converted into mechanical motion, and this mechanical motion be converted back into heat, the utilization of this heat to produce mechanical motion a second time will not accomplish so much work as before, showing a dissipation of heat in the process of transformation.

According to theory, therefore, the mechanism of the universe is actually on the principle of two watches, so arranged that the running down of the main-spring of one winds up the main-spring of the other, and *vice versa*. But in the actual experiment with two watches, some of the energy is dissipated through the friction of the machinery; and while the mechanism can be long kept going by this mutual process of transformation of one kind of energy into the other, yet after each transformation the reservoir of potential energy contains less than before, and presently the two watches must run down. Since all man's experimental attempts to establish a perpetual transformation of energy have been baffled by this dissipation of energy, the scientist has concluded that the dissipation of energy is a law of the universe, and that in the course of millions of years the great physical clock-work must run down—despite the fact that the sum-total of energy is unchangeable, and that nature is ingeniously contrived so as to utilize it for work over and over again, during a very long period of time.

But is the dissipation of energy an inevitable deduction? To show that the Biblical-Tychonic theory avoids the necessity of making this deduction, is to show that it is vastly superior to the Newtonian-Copernican system as a basis of natural philosophy. Scientists have always felt that could the Newtonian and Copernican hypotheses help us to formulate a rational conception of how the physical universe might self-subsist indefinitely, this would go far toward demonstrating their truth. La Place thought he had effected this, for had he really demonstrated the stability of our solar system, it would be natural to account for all solar systems, and the entire universe, on the same basis. But time has demonstrated, instead, the failure of La Place, as well as of his predecessors and successors, as Professor Hall concedes; while through the lack of such a demonstration physicists have been forced to the other extreme of postulating the principle of the dissipation of energy, involving the ultimate relapse of the universe into passivity and immobility.

But when we accept the Biblical-Tychonic system, and conceive the sun to be the grand reservoir of potential energy, which it is constantly giving forth as kinetic energy to maintain the mechanism of the universe, it becomes

perfectly rational to think of the sun as receiving again all the kinetic energy which is dissipated in the process of doing work, and which is not stored as potential energy in a practical form for use in some part of the physical mechanism of the universe. Those familiar with the fruits of the study of the sun already reaped by the more rational "New Astronomy," will recognize that the theory we have just propounded would seem to fit very well the remarkable phenomena connected with the sun. Moreover, we have the analogy for such a theory before us.

We have seen that the directing of a current of electricity about a bar of soft iron will transform the latter into a magnet during this process. When the current ceases the soft iron ceases to be a powerful magnet; and yet it is a fact that after the iron apparently ceases to be a magnet, it is possible to utilize it to generate a current of electricity as strong as that which had previously magnetized the iron. This is seen in the dynamo-electric machine, which is frequently constructed by an arrangement of coiled wire which may be made to revolve about soft iron which has been treated by electricity in the way described. Though the iron has apparently ceased to be a magnet, yet it is capable of generating a slight electrical current in the coils revolved about it; the current thus generated increases the magnetism of the iron, which is in turn enabled to generate a stronger current in the coils, this process continuing until the strength of the electrical current and of the magnet alike equal the capacity of the machine. By such a process of resurrection is power habitually generated, after the machine has been stopped and electricity and magnetism have apparently disappeared.

In the huge mechanism of the universe which we have assumed, the earth is the large central magnet, and has the virtue of acting as a permanent magnet through the constant electrical ministry of the sun. The two movements of the sun answer to the coil about the magnet. This will be clear if we suppose that the sun in his course is wrapping an imaginary wire about the earth, in the path of his vertical rays upon the earth's surface. From March 21 to June 21 he is daily encircling the earth, while at the same time gradually moving toward the north. Thus the imaginary coil laid upon the earth's surface would be like the winding of a top-string from the Equator to the Tropic of Cancer. From June 21 to September 22 the path of his vertical rays would wind a similar coil from the tropic back to the equator; while from September 22 to March 21 a similar coil would be laid between the equator and the Tropic of Capricorn, with a return coil from the latter to the equator. The coil is of course imaginary, but the movements which it pictures—according to the Biblical-Tychonic system—are not. On the contrary, there is the sun's annual journey and his exceedingly swift daily motion about the earth, while during all this time his huge incandescent bulk is revolving upon its own axis and radiating its energy in the vertical rays which strike the earth in the line of our imaginary coil, and in the slanting rays which strike the earth elsewhere, at varying angles, illuminating

one-half of its surface continually! This energy, lavished upon the earth, we may assume to be the source of its primary magnetism, which theorists have styled terrestrial gravitation, as well as the source of the terrestrial phenomena of heat, light, chemical energy, electricity, (secondary) magnetism and mechanical motion. And at the same time the great terrestrial magnet reacts with equal effect upon the sun, on a principle analogous to the action and reaction of electric current and magnet in our dynamo-electric machines. Thus could we account in a rational way for the close connection between special electrical phenomena on the earth, such as magnetic storms and the Aurora borealis, and special activity at the sun, as revealed in the appearance of many so-called spots.

The other features of the celestial mechanism would all seem to find harmonious explanation on this basis. We would reverse the present theory as to sun and earth, representing the sun as held in his orbit in an equilibrium representing the balance between the attracting force exerted upon him by the magnetism of the earth and the electrical or thermal repulsion exerted by him against the earth. Will it be objected that we cannot conceive of the earth as exerting such a force upon the immense mass of the sun? He who reasons thus is simply preoccupied with the idea of gravitation, whereas we are speaking of magnetism. It is not a question of the gravitation of the earth grappling with the sun's mass, but of a magnet drawing an immense but very magnetic body. This force of magnetism would be inversely as the square of the distance, but would be otherwise determined by the power of the magnet and the magnetic nature of the sun, so that however formidable the other factors (the sun's mass, distance and radiant repulsion), these would simply be the elements for measuring the power of the magnet and the degree in which the sun's mass is magnetic.

In the same way, the moon would be held in an orbit about the earth by the magnetism of the latter, while being kept in equilibrium by radiant repulsion. This radiant energy of the moon would of course be of a secondary nature—received from the sun and projected against the earth. This might be reinforced, however, by a secondary electrical current caused by the moon's own motion about the earth, on the principle of the induction coil, or of a secondary electrical current induced by a primary current—that of the sun in this case.

Nor is this solution less remarkable for the apparent ease with which it explains the phenomena of the planets and of the sphere of fixed stars. Here we must evidently distinguish between the inferior, or inner planets, Mercury and Venus, and those whose orbits lie entirely outside the orbit of the sun about the earth—Eros, Mars, the Asteroids, Jupiter, Saturn, Uranus and Neptune. There was general skepticism among astronomers when Schiaparelli announced about twelve years ago that Mercury and Venus were like our moon, revolving but once upon their respective axes in making

the circuit of their respective orbits, and thus always keeping the same side turned toward the sun, just as does the moon toward the earth, the attracting power acting like a rigid rod soldered to the point on the surface of each revolving globe which remains vertical to the imaginary line described on the surface of the respective attracting body by the vertical rays of each revolving globe as it makes the circuit of its orbit. But Schiaparelli's observations were confirmed by those of Perrotin, and in 1896 by those of Percival Lowell, and astronomers have apparently concluded that this anomaly must be grappled with. In the present solution, on the Biblical-Tychonic basis, we accordingly assume that Mercury, Venus and the Moon operate on a somewhat different principle than that which controls the great exterior planets, each of which, the astronomers still assure us, rotates upon its axis like the sun.

For the electrical explanation of the relation existing between the sun on the one hand, and the exterior planets and the revolving star-sphere on the other, we resort to the analogy of the induction coil. Here the primary current is produced in a coil of wire wrapped around a spool or bobbin which will fit inside a larger bobbin, similarly wrapped and connected with a galvanometer. A secondary electric current is induced in the coil about the large hollow bobbin by placing inside of it the inner coil in which a current has been produced. This induced current in the outer coil is made still stronger by also making the inner hobbin hollow, and placing within it a core of soft iron, or some other form of magnet. But this is precisely the principle of the mechanism of the physical universe, according to the electrical solution of the Biblical-Tychonic system! The earth, a central magnet, answers to the magnetic core; the sun, outside of this, with the movements we have described, answers to the coil on the inner bobbin which provides the primary current of electricity; the revolving star-sphere outside the sun, with the exterior planets—celestial bodies with whom both motion and luminous phenomena are induced by the primary energy of the sun—answer to the outside coil, in which the secondary current is induced.

As we compare details, the analogy becomes only the more striking. For example, although the secondary current is induced in the way described, it will soon cease if the primary coil be left stationary inside the secondary coil, but is maintained by the process of rapidly lifting the primary coil out of the other and inserting it again. The intensity of the induced secondary currents is in proportion to the rapidity of this movement. In the commercial application of the principle, the same effect is produced by mechanical means which rapidly break the current which passes from the battery to the primary coil; and with the alternating currents obtained with the introduction of a condenser, the most powerful electrical currents known to commerce or the laboratory are secured. The intensity of the secondary currents which may be obtained greatly exceeds that of the primary current; and it is not too much to say that on this principle we could conceive of our sun as the motive

power of the entire universe, as well as of the solar system, even though the universe should be postulated on the scale which the Copernican hypothesis requires. In this case we would allow, for the sake of the demonstration, that there are countless stars, as large or larger than the sun, as orthodox astronomers now assert, but that all these receive their light and energy from our sun, instead of being themselves independent suns.

In the electrical device we have taken as affording the analogy, the current in the primary coil is furnished by a battery. In the celestial mechanism this battery would be represented by the sum-total of potential energy with which the Creator has endowed the physical universe. Hence in the case we have supposed, the sun would have had as his original supply all the energy now dispersed throughout the universe. And since it is an observed law of the electrical arrangement referred to, that the intensity of the induced current is proportional to the primary current, it is plain that an endowment of the sun with the sum-total of energy in the physical universe would have enabled him, on the principle we are considering, to have distributed the energy now permeating the universe.

According to another principle of our mechanism, the intensity of the secondary current is proportional to the rapidity with which the primary current is broken. The nearly semi-annual journeys of the sun between the celestial tropics, while at the same time daily whirling about the earth, would produce a spiral movement within the star-sphere like the shifting of the primary coil up and down within the secondary coil of our electrical model. Yet this semi-annual movement up and down in space would scarcely be considered swift enough of itself, so that we will assume that the daily revolution about the earth is such as constantly to break the current, while the strange rotation of the sun upon its axis might also serve in some way to this end.*

Again it has been found that the intensity of the secondary currents are proportional to the square of the resistance in the secondary coil; and on this principle, the greater the magnitude of the star-sphere, the greater would be the intensity of the currents induced in it by the sun. Hence to the electrical solution distance and masses present no difficulty, these factors but increasing the power in proportion to their requirement of it.

Returning now to the question of the dissipation of energy. On the basis of the electrical theory of the mechanism of the physical universe, we have as little reason for conceding the ultimate termination or diminution of kinetic energy as we have for conceding the doctrine of conservation of energy in the way that Helmholtz taught it, confusing the phenomena of psychical and spiritual life with what is but its type in inanimate nature—physical force. So far as the physical universe is concerned, the principle of action

* The strange fact that the sun's bulk appears to rotate on its axis in sections, some parts making the revolution in less time than others, has so far remained inexplicable to the most ingenious among Newtonian astronomers.

and reaction, observed in the mutual response of electricity and magnetism, leads the rational mind to assume that the sun, the reservoir of potential energy for the entire universe according to the Biblical-Tychonic system, eventually receives again all the energy radiated by him to propel the vast machinery under his charge, thus providing the power for an endless communion with the mechanical life which he everywhere creates.* I need scarcely add that in this, in the Biblical-Tychonic system, he is merely the type of his Creator, and of the relation of Creator and creature in the moral and spiritual universe.

IV. Another striking testimony in favor of the Biblical-Tychonic theory is given by the spectroscope, which indicates incandescent metals as the chief constituents of the fixed stars. This is precisely what our present knowledge of electricity would lead us to expect, provided the Creator desired to utilize the energy imparted to the sun so as to maintain an innumerable array of electric lights in the firmament. Carbon is perhaps the most economical conductor of high resistance; and the incandescent electric lights of commerce, which strikingly suggest miniature fixed-stars, are obtained by raising to a white heat a thin strip of carbon arranged between the poles of a voltaic battery which generates a strong current. Carbon poles are used in the production of the arc-light. With the analogy of the incandescent electric light before us, we may dismiss the inconceivable sizes and distances which the Newtonian-Copernican hypothesis compels us to assign to the fixed stars, and can at the same time understand why they disclose no disks when observed through the telescope. On the basis of a grand electrical plant we can also account in a rational way for the phenomena—extraordinary indeed on the present hypothesis—of the extinction of the light of fixed stars, to be reappear again in a short period—a thing which on the basis of current theory may very well induce Prof. S. P. Langley to exclaim, "It is surely an amazing fact that suns as large or larger than our sun should seem to dwindle almost to extinction, and regain their light within a few days or even hours; yet the fact has long been known, while the cause has remained a mystery!" †

The somewhat different phenomena of planetary illumination are equally explicable on the electrical basis. With a large induction coil, such as we have described, a display of lights which is varied and unique is possible. By passing the induced currents through sealed tubes of different forms, from which the air has been partially pumped, with the substitution of different gases, effects have been produced analogous to nearly if not quite all the planetary phenomena, including the rings of Saturn. When the

* Writes Prof. C. A. Young (*The Sun*, 1881, p. 277): "Neither is it wholly safe to assume that there may not be ways, of which we yet have no conception, by which the energy apparently lost in space may be returned, and burned-out suns and run-down systems be restored."

† "The New Astronomy," 1880, pp. 227-8.

tubes are rotated on axes, producing a movement corresponding to the axial rotation of the superior planets, the effect is still more brilliant.

V. In favor of the Biblical-Tychonic theory is the undoubted fact that the sun maintains the solar system, and sustains all physical energy on the earth, in precisely the way required by this theory, in order to render him a physical type of the moral relation which God sustains to his creation, as well as a type of the work of redemption and new creation wrought by Christ. Says Professor Langley:

"Within a comparatively few years a new branch of astronomy has arisen which studies sun, moon and stars for what they are in themselves, and in relation to ourselves. Its study of the sun, beginning with its external features (and full of novelty and interest even as regards those), led to the further inquiry as to what it was made of, and then to finding the unexpected relations which it bore to the earth and our own daily lives on it, the conclusion being that, in a physical sense, it made and re-creates us, as it were, daily, and that the knowledge of the intimate ties which unite man with it brings results of the most practical and important kind, which a generation ago were unguessed at." *

To assign to the sun such an office as this, in relation to the earth and all life upon it, is to vindicate the claim of the Bible in a most remarkable way. For Scripture especially directs us to the celestial phenomena for a testimony of the Creator's relation to His creature: "The heavens declare the glory of God, and the firmament sheweth His handiwork: day unto day uttereth speech, and night unto night sheweth knowledge" (Ps. xix. 1, 2). Moreover, Scripture maintains that this testimony through nature leaves men without excuse: "Because what is known of God is manifest among them, for God has manifested it to them—for from the world's creation the invisible things of Him are perceived, being apprehended by the mind through the things that are made, both His eternal power and divinity—so as to render them inexcusable" (Rom. i. 19, 20). And it is God's goodness and kindness toward His creature which is disclosed in the sun's service—a kindness to saint and sinner, the grateful and the ungrateful, since "He maketh His sun to rise on the evil and on the good, and sendeth rain on the just and on the unjust" (Matt. v. 45). In the following, Prof. Langley shows how the sun typifies the Creator, in His impartation to the various works of His hand, through creation and the processes of life, of varying measures of His own virtue and energy:

"Did the reader ever consider that, next to the mystery of gravitation, which draws all things on the earth's surface down, comes that mystery—not seen to be one because so familiar—of the occult force in the sunbeams which lifts things up? The incomprehensible energy of the sunbeam brought the carbon out of the air, put it together in the weed or plant, and lifted each

* *Ibid.*, pp. 3, 4.

tree-trunk above the soil. The soil did not lift it, any more than the soil in Broadway lifted the spire of Trinity. Men brought stones there in wagons to build the church, and the sun brought the materials in its own way, and built up alike the slender shaft that sustains the grass blade and the column of the pine. If the tree or the spire fell, it would require a certain amount of work of men or horses or engines to set it up again. So much actual work, at least, the sun did in the original building; and if we consider the number of trees in the forest, we see that this alone is something great. But besides this, the sun locked up in each tree a store of energy thousands of times greater than that which was spent in merely lifting its trunk from the ground, as we see by unlocking it again, when we burn the tree under the boiler of an engine; for it will develop a power equal to the lifting of thousands of its kind, if we choose to employ it in this way. This is so true that the tree may fall, and turn to coal in the soil, and still keep this energy imprisoned in it—keep it for millions of years, till the black lump under the furnace gives out, in the whirling spindles of the factory or the turning wheel of the steamboat, the energy gathered in the sunshine of the primeval world.” *

And if He of whom the sun is but the type, dividing severally to His creatures as it has seemed good to Him, has made some in His own image, with intelligence, moral capacity and the energy of will-power to do either good or ill, will not such be required to account to Him for their misuse of this endowment? If in creating man a spirit, virtue and energy in a special sense have gone forth from God, the Eternal Spirit, must not this spirit in man return to Him who generated it? Surely, when dissolution shall have come upon such a creature, “Then shall the dust return to the earth as it was; and the spirit shall return unto God who gave it” (Ecc. xii. 7). Helmholtz formulated the law of the conservation of energy in the interest of the grossest materialism, as he supposed; but since it is a true law of nature, its testimony is very plainly against materialism. It helps not an iota toward the unnatural and unscientific attempt to identify the life of soul and spirit with physical energy; while on the other hand it affords the most striking intimation of the eternal indestructibility of soul and spirit, and of the eternal accountability to God of the spiritual energy which He has begotten in moral creatures! Again, Professor Langley shows that the sun affords a type of God’s disposition and ability to take up anew, in new creation, the fallen creature which submits to His hand:

“The sunbeam does what our wisest chemistry cannot do: it takes the burned out ashes and makes them anew into green wood; it takes the close and breathed-out air, and makes it fit to breathe by means of the plant, whose food is the same as our poison.”

In the sun that takes up the burned-out ashes to make again the green

* *Ibid.*, pp. 72-3.

wood, we may surely see a type of the God of resurrection of our Bible! We may also notice how plant-life, through communion with the sun, is able to attain to a beautiful and fruitful development in a poisonous atmosphere. Aided by the chemical energy of the sunbeam, the chlorophyl and protoplasm in the plant-leaf are able to break up and assimilate the carbon dioxide thrown off by animal lungs, storing up energy in its own structure by building up complex molecules. As food and fuel the plant affords the energy which supports animal life and furnishes power for many of man's machines.

Says Professor Langley:

"With the aid of sunlight a lily would thrive on the deadly atmosphere of the 'black hole of Calcutta'; for this bane to us, we repeat, is vital air to the plant, which breathes it in through all its pores, bringing it into contact with the chlorophyl, its green blood, which is to it what the red blood is to us; doing almost everything, however, by means of the sun ray, for if this be lacking, the oxygen is no longer set free or the carbon retained, and the plant dies."

Thus we have a picture of how the Christian, if born from above, may, in the sunshine of communion with Christ, through God's Word, become fruitful in a world the ways of which are but too faithfully suggested by the animal kingdom, manifesting in such a scene, as Christ manifested here, the fragrance, moral purity and lowly usefulness in self-sacrifice for others which the plant suggests! That "Every good gift and every perfect gift is from above, and cometh down from the Father of lights" (Jas. i. 17), is also the testimony of the sun, according to Professor Langley:

"The ox, the sheep, and the lamb feed on the vegetable, and we in turn on them (and on vegetables too); so that, though we might eat our own meals in darkness and still live, the meals themselves are provided literally at the sun's expense, virtue having gone out of him to furnish each morsel we put in our mouths."

Here we have the type of a Creator who is likewise "the Preserver of all men" (I. Tim. iv. 10), giving over all nature into their hands. Nor is He at the expense of all that man enjoys simply as Creator; for He can not righteously preserve the unrighteous and bestow gifts upon them, except as He Himself pays the penalty for all the evil toward which he displays forbearance. And so the sun is also the type of Him who for His creatures has been at the expense of the Incarnation, and of the Atonement wrought by suffering all the deserts of evil at the cross! Indeed, in this way the Creator has not merely provided nourishment for His creatures through creation and providence, but has made Himself, and the moral display of His glory in humiliation and atoning death, the spiritual food of the household of faith. In John vi. 32-65 He presents Himself to men thus, as the Bread of God, the Bread of life, the Bread Who came down from heaven in order that a man might eat thereof, and not die! In His meek and gentle Manhood, as in a prism, the dazzling glory of Infinite Light has been graciously

refracted, with all the beautiful moral glories of God spread out, side by side, in the life and death of Jesus: a softened diffusion of the Light which does not repel nor blind the poor sinner, but opens his eyes to behold the glory of God, while there is shed abroad in his heart the love of God. Professor Langley continues:

"But while He thus prepares the material for our own bodies, and while it is plain that without Him we could not exist any more than the plant, the processes by which he acts grow more intricate and more obscure in our own higher organism, so that science as yet only half guesses how the sun makes us. But the making is done in some way by the sun, and so almost exclusively in every process of life. . . . To make even the reader's hand which holds this page, or the eye which sees it, energy again went out from the sun; and in saying this I am to be understood in the plain and common meaning of the words. . . . Is there not a special interest for us in that New Astronomy which considers these things, and studies the sun, not only in the heavens as a star, but in its workings here, and so largely in its relations to man?"

Truly there is a special interest, and great profit, provided that our study of the sun is to enable us to read aright deeper lessons than simply these relations of creature to creature. But we must carefully avoid a construction which might be put upon Professor Langley's language here—as if the sun could "make" the whole man, soul and spirit. It is man's body alone, that which links him to the physical universe, which is manufactured and replenished in the sun's laboratory: soul and spirit are beyond his chemistry, though he can fashion for them a house of clay. If we study not the sun as a type, we may also forget that he is after all but a blind agent, and that the hand behind him is the hand of God, and so fall into the snare of being unthankful, changing the truth of God into a lie, and reverencing and serving the creature more than the Creator, who is blessed forever! With this qualification, we agree with the following:

"Since, then, we are the children of the sun, and our bodies a product of its rays, as much as the ephemeral insects that its heat hatches from the soil, it is a worthy problem to learn how things earthly depend upon this material ruler of our days."

Thus not alone is the Biblical-Tychonic theory equal to the Copernican hypothesis in its intrinsic competence to account for all the observed phenomena, but in connection with it a rational solution at once appears which also embraces all the phenomena of the physical universe in one homogeneous relation.

I will now mention some further objections to the Newtonian solution of Copernican theory. Five points were made under this head as an introduction to the consideration of the Biblical-Tychonic theory. The next count will therefore be the sixth.

VI. To a rational philosopher it must surely seem much against the recognition of universal gravitation as a law of nature that it remains an anomaly in the universe, with no affinity to any other known force. This objection had little weight in Newton's day, because the correlation of natural forces was not then a principle recognized by science. The character of the known forces was then almost as inexplicable as that of gravitation itself, while it remained to be seen whether the postulate of universal attraction would not prove a key to reconcile all things. But now the close relation of all forces (gravitation excepted, if we must indeed still postulate it) is so well established, that were the hypothesis of universal gravitation introduced in these days, instead of having the advantage of long occupation of the field in its favor, and the powerful ally of universal prejudice, there can be little doubt that its inharmony with the other and closely-related forces would bar it from serious consideration. Gravitation is an anomaly in the presence of the kindred group, including heat, light, actinic energy and electricity, while magnetism is of this kindred. It appears to be an inadequate deduction which has declared that terrestrial gravitation is not a phase of magnetism—and that in the face of the well-known fact that the earth is a magnet with magnetic poles. Why is the whole earth electrical?

VII. But not alone is the theory of universal attraction an anomaly: it is and always has been contrary to reason, judged on the basis of the scientific definition of reason as applied to the physical universe. The contradiction here introduced into the very foundation of modern science (for Newtonian-Copernican orthodoxy is its foundation) is most curious and most significant, although scientists themselves either have mainly failed to face the situation squarely in their own minds, or else have skillfully avoided discussion of a tender subject before the public. For materialism is the badge of that supreme aristocracy and inner priesthood whose members consider themselves the only pure scientists, and in their zeal against the Bible and its miracle-working God they have pronounced a general ban upon whatever does not conform to known laws of nature, as being irrational and manifestly false. And yet that corner-stone of scientific hypothesis, Newton's postulate of attraction as a universal law of nature, requires of the mind a blind credulity not at all required in order to credit all the miracles of Scripture! For the miracles of Scripture are the most credible things in nature to one who accepts the only premise on which Scripture puts them forth—the postulate of a personal God who loves man and wishes to make Himself known to him, Who arranged the mechanism of the universe with the special purpose of revealing Himself to man thereby, and Who proves to man that He is nature's God by demonstrating His superiority to the mightiest laws which He has ordained for his creation! Does the Bible ask me to believe in miracles? Very well, since it reveals to me a God who can work them! But the Bible does not demand of me to utterly outrage my reason, by requiring me to believe in the miraculous, while at the same time suggesting that there is no personal God to accomplish the wonder!

But this is precisely the thing which modern science does, the hypothesis of universal attraction requiring just such a prostitution of the human reason. What is more, Newton's hypothesis has been embraced by men who were perfectly aware that in accepting it as a working basis they must stultify their reason, for it is well known that Newton himself conceded as much. After exhausting every resource even of his ingenious mind to find at least some rational basis for the conception of universal gravitation, since an analogy in nature was out of the question, Newton finally presented his law on the postulate of the miraculous, having conceded that to the finite mind the action of universal gravitation is paradoxical, while the phenomenon itself is absolutely inconceivable—although, according to his theory, it must be true! Is it not a wonder that scientists have doubted the existence of a personal God in connection with a universe organized on such a principle?

The fundamental absurdity of this dogma has been frequently set forth, and can be concisely put. Either space contains a material medium or it does not. If it does not, and yet every atom of matter in the universe attracts every other, we have the absurdity of matter acting through vast spaces where it is not, without the assistance of any intervening medium! The supposition outrages all we know of nature, making a plaything of the human intellect! But if space contains a material medium, and all matter is mutually attractive, then the universe consists of matter which is pushing and jamming itself together. This has been accepted in modern times as the lesser of two evils, the scientist exerting his will-power to forget the utter absurdities which it also necessitates. If the universe is full of matter, and all this matter is pressing together, then of course the universe has been an immovable mass since its creation! But since the evidence everywhere before our eyes refutes this, there is nothing for us except to postulate another universal law, to the effect that all matter tends to separate! It is perfectly plain that if there is an inherent tendency in all matter to come together, and at the same time an inherent tendency to draw apart, the two laws will explain almost everything, while in working out the details we may always conveniently lose sight of the fundamental paradox! But does the reader—the uninitiated lay-reader—think it impossible that learned scientists should arrive at such conclusions, as the result of all their profound cogitations over the more-than-miracle of Newtonian attraction!

Let such a reader consult Mr. William B. Taylor's treatise on "Kinetic Theories of Gravitation," published in the Annual Report of the Smithsonian Institution for 1876. Indeed, this paper will repay study on the part of anyone wishing to know more in detail the depths of the credulity of scientific minds in accepting the postulate of universal attraction. Mr. Taylor cites Newton's third letter to Bently, dated February 25, 1692-3, or about ten years after Newton had propounded his famous hypothesis, in which he says: "That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance, through a vacuum, with-

out the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking can ever fall into it." But Mr. Taylor, who is a devoted disciple of Newton, rebukes sceptics who would use this testimony against this conception of gravitation, on the ground that Newton was himself compelled, twenty-five years after penning this stricture, to embrace "so great an absurdity!" For after a quarter of a century of vain search for some better conception, Newton "despairingly" asked: "Have not the small particles of bodies certain powers, virtues, or forces, by which *they act at a distance*? . . . What I call 'attraction' *may* be performed by impulse, or by some other means unknown to me." But all this shows is that in his old age, with a pet theory and a reputation to sustain, and in the desperation born of utter failure to find a more rational alternative, Newton embraced an "absurdity so great" that he himself had pronounced, ere he realized he should be shut up to it, that "no man who has in philosophical matters a competent faculty of thinking can ever fall into it." Thus, according to the Newton of 1693, who was in his prime, the Newton of twenty-five years later had lost, through prejudice, the competent faculty of thinking in philosophical matters! And what a commentary upon all his devoted followers since, whose faculty of thinking in philosophical matters has been so incompetent that they, too, have fallen into the same great absurdity!

The well-known astronomer, J. E. Gore, published in the *National Review* (reprinted in *Littell's Living Age*, No. 2489, March 12, 1892) an article based upon that of Mr. Taylor, in which he concedes the logic of the latter's conclusions. These conclusions are remarkable. Having defined the elements absolutely essential in any explanation of gravitation, and having tested by this standard the attempts at explanation made by the succession of astronomers and physicists who have labored to reconcile the postulate with human reason, only to find them all sadly inadmissible, Mr. Taylor demonstrates that not an iota of progress has been made in two centuries toward an explanation of gravitation as a kinetic force. In other words, to conceive of gravitation as an *active* force lands us in all sorts of contradictions. But to think of work being done by a *passive* force is perhaps even more ridiculous. Hence Mr. Taylor declares that all that is left to us is to conceive of an "occult" force of universal attraction! But even this, of itself, is wholly inadequate to explain the phenomena, and so we must double the wonder of a paradox already inconceivable. According to Mr. Taylor we must conceive of an "occult" quality inherent in matter in virtue of which the ultimate atoms *attract* one another whenever separate from one another, and in virtue of which they *repel* one another whenever they are in close proximity! This is the conclusion of what is probably the most profound and comprehensive investigation of this problem ever undertaken.

For myself, I must beg to decline it, even though I must stand as a

minority of one, or in the company of a few simple Christians like President Kruger, of the Transvaal. When it comes to a question of an "occult" force which repels when it should most powerfully attract, and attracts when it is most free to fly apart—then I must prefer *known* forces like electricity and magnetism and chemical energy, which are *known* to produce both attractive and repulsive phenomena, together with the Biblical-Tychonic system, which seems to be demonstrable on this basis without dethroning the human reason in the process.

And I would remind Christians, who have not the faith to follow me in the unreserved acceptance of the Biblical system of astronomy, that they still have the best of the materialists, even when the latter have chosen their own ground in the dogma of Newtonian infallibility. The Christian may say: "You tell me that I must concede the existence of an 'occult' quality inherent in matter in virtue of which the ultimate atoms repel one another when in close proximity and attract one another when not in close proximity, since, however paradoxical the postulate may seem, the motions of the celestial bodies are otherwise inexplicable. Very well; only this force, which to the unenlightened reason of the most profound scientists is 'occult,' is no mystery whatever to the Christian, who from Revelation has learned that the force which accomplishes results so remarkable is simply the fiat of the Creator and Preserver of the universe, Who is ever 'upholding all things by the word of His power' (Heb. i. 3)!" These prodigious labors of the profoundest intellects for two centuries to show that the universe can dispense with its Creator—how small the mouse they have brought forth!

VIII. Dr. Schoepffer is absolutely correct in saying that gravitation, if consistent with the other laws of nature, would prevent the axial rotation of any body which by gravity is maintained in equilibrium in an orbit of revolution about an attractive centre, with the exception of a single rotation during the orbital revolution, on an axis perpendicular to the plane of the orbit. Were it true that attraction acted as if concentrated at the centre of attracting bodies, there could also be rotation on an axis one of whose poles was fixed at the point on the surface of the rotating body which is ever directed toward the centre of the attracting body about which it performs its orbital revolution. The only answer to Dr. Schoepffer is the one we have considered: that gravitation is very strange in its ways, very "occult," and makes no profession of consistency with the other laws of nature! Tack a string to a ball, hold the other end of the string in the fingers, and swing the ball in a circle with sufficient velocity to keep the string taut: here you have the resolution of attractive pull and centrifugal tendency known to nature. Because the attracting pull is constant, throughout its orbit of revolution, the ball ever presents one point on its surface to the attracting power. During its orbital revolution the ball rotates once on an axis perpendicular to the line of attraction. But as the string twists, the ball may also rotate many times on an axis one pole of which is the point where the string is

attached. The latter form of rotation would not be possible with a celestial body moving about an attracting centre, for according to theory the two bodies would not be held as by a string from centre to centre, or from surface to surface, but would be held by innumerable taut strings binding each atom in each body to every atom in the other body. This would hold the two bodies, hemisphere to hemisphere, as in a vise; while if one described an orbit of revolution, the attracting centre must also during this period rotate once on its axis, so as to keep the same hemisphere toward the body encircling it. But no celestial phenomenon conforms to this supposition. If the earth so responded to the moon, the latter would always be vertical to a certain point on the earth's surface; from any given point on one-half the earth's surface, would always, by day and by night, appear in the same spot in the heavens; and from all parts of the other hemisphere of the earth would always be invisible. It is equally plain that if the sun responded thus to one of the planets, he could not at the same time do so to any of the others; whereas, in fact, he responds thus to none, his axial rotation being synchronous with no planetary revolution.

But it seems legitimate to conceive that large attracting centres, though practically controlling smaller encircling bodies, would not themselves be controlled by these smaller bodies. But it would still hold true that the smaller body would be held as in a vise, with one hemisphere ever toward the attracting centre of its orbit, for the power which held it in its orbit, according to theory, would be exerting all this power rigidly *on each of the atoms* of the revolving body throughout its orbit. The result would be that the smaller body would perform its orbital revolution with one hemisphere ever toward the attracting centre. This should be true alike of Newtonian-Copernican gravitation, and of Biblical-Tychonic electro-magnetism. As Dr. Schoepffer pointed out, this is what we find in the case of the moon, whose attracting centre is the earth. His argument is now notably emphasized by the conclusion of Schiaparelli, Lowell and others, attesting the like phenomena in the orbital revolutions of Mercury and Venus about the sun. Thus if the Moon, Venus and Mercury conform in this particular to the theory that all the atoms of each are attracted by all the atoms of sun and earth, then it is certain that the axial rotation of the earth and of the superior planets is in direct violation to Newtonian theory.

IX. A special point should be made of the fact that Newton's postulate contradicts observed phenomena, unless we agree to think of the attracting force of each body as acting as if concentrated at its centre; while (1) the very terms of the hypothesis of universal attraction make this assumption a confessed fiction, so that (2) the physical explanation of axial rotation on this basis is absolutely fraudulent. The first of these propositions we may state thus: either the hypothesis, that every atom in the universe attracts every other atom, is true, in which case it cannot be mathematically correct to consider the attracting power of spherical masses containing many atoms

as if concentrated in one atom at their centre; or, if the last proposition is mathematically correct, then every atom in the universe does not attract every other atom, and the entire structure of Newtonian philosophy falls to the ground. But theoretical astronomers ask us to conceive of the attracting power of spherical masses as if concentrated at their centres simply as a convenient approximate of the truth, to facilitate mathematical demonstration; for it is plain that the celestial bodies must be dealt with as if mere points, in order that mathematical astronomy may secure the terms on which its conclusions are based. To this I object, (1) that this concession cannot properly be asked of one who does not concede in advance the truth of the Copernican postulate of immense distances, and (2) even of one who does concede the postulate of immense distances, the concession that the attracting power is concentrated at the centre of spherical bodies cannot properly be asked when the relations of our solar system are the subject of investigation. For if we concede the inconceivable distances assigned to the fixed stars, in dealing mathematically with bodies at such distances no very appreciable error would result from regarding them as mere points. But in the solar system it is not quite so. Shall we build up theory on the fiction that the sun's attracting power is concentrated at his centre, when we reflect that his estimated diameter is so immense that within its space the moon could describe her present orbit about the earth, and could still do so were her orbit $1\frac{1}{2}$ times its present size, or when we reflect that the sun's estimated diameter is about $1-108$ th of its estimated distance from the earth?

Still this is comparatively trivial and may be allowed for in results. The serious and fraudulent feature consists in inducing us to concede, for the convenience of mathematicians, that the attracting force of spherical bodies is concentrated at their centres, while on the basis of this concession they then go on to assume an axial rotation for the earth and planets which would only be *possible* in case the convenient fiction, of the concentration of the resultant of gravitation at the centres of bodies, were a physical fact. Let us take the case of the earth. The axial rotation assumed for the earth, in order to explain the phenomenon of day and night, is mechanically possible only on one of two suppositions: (1) in case it is a physical fact that the attracting power of the sun is concentrated in a pull upon the atom at the earth's centre, *and affects no other atom in the earth's mass*; (2) in case the rotation of the earth is caused by some constant force which is more powerful than the sun's attracting power exerted upon the earth; for if this attracting power of the sun is concentrated upon each and every atom in the earth's mass (as theory requires), and yet these atoms, so acted upon, can be moved in a direction opposite to that of the sun's pull by some force which causes the earth's axial rotation, then this rotating force must be capable of constantly overcoming the attracting force which holds the earth in her orbit! But if this be so, what then holds the earth in her orbit? Thus it has only been by means of the fiction that the power of the sun, which holds the earth

in the orbit assigned to her by theory, is concentrated in a pull upon the earth's centre, that astronomers and physicists have been able to conceive for the earth a daily rotation on an axis nearly perpendicular to the plane of her orbit. Yet Newton's postulate of universal attraction is fundamentally false unless every atom of the earth's mass is attracted by the sun's mass; while if the sun attracts all the atoms in the earth's mass, then instead of speaking so frequently of centrifugal force as a product of the earth's rotation, as if the earth could rotate under these circumstances without the agency of tremendous energy, our philosophers must seek some powerful, independent ("occult"?) force to produce the rotation—one powerful enough to induce a rotation of the earth which can only be obtained by the overcoming of the attracting force! Thus the two motions which Copernican hypothesis necessarily postulates for the earth, are mutually destructive when explained on the hypothesis of universal attraction. Mathematical astronomers have always avoided the difficulty by a glaring sophistry: the invention of a fiction as the very first step in their so-called "solution," while this fiction involves the positive contradiction of the fundamental hypothesis employed in the "solution"!

X. Since the postulate of axial rotation (except as exhibited by the moon, and probably by Venus and Mercury) is irreconcilable with Newton's postulate of universal attraction, it follows that much of accepted astronomical theory contradicts Newton's postulate. The evolutionary nebular theory of the universe, in vogue since Laplace gave it currency, makes axial rotation its basic principle. Moreover, the theory of tidal friction, suggested by Kant and developed by Lord Kelvin and Prof. G. H. Darwin, is now quite popular, and requires axial rotation of the celestial bodies as its basis. Axial rotation generates centrifugal force, while the latter tends to hold back the liquid matters on the surface of the rotating body, thus causing a tidal friction which gradually retards the rotation. Prof. G. H. Darwin solemnly proclaims a time when the Moon, thrown off by the centrifugal force of the earth's swiftly-rotating mass, was very close to the earth, each of these bodies then making a revolution on its axis in about two hours! Tidal friction has slackened the rotation of the earth until an axial revolution now requires about twenty-four hours, while the same agency has entirely overcome the rotating energy of the Moon! Prof. J. J. See has extended the application to the fixed stars, explaining the development of so-called "double stars" on the hypothesis of tidal friction, while he and others naturally apply the same solution to the new discovery respecting Mercury and Venus. In fact, astronomers would not know how to account for the spherical form of the celestial bodies, on an evolutionary basis (which is very dear to them), except on the hypothesis of axial rotation. Yet none of these gentlemen have yet explained how the heavenly bodies may be controlled by universal attraction, while at the same time an axial rotation which necessarily annuls the attracting force, is constantly at work! It is also true that to concede the princi-

ple of tidal friction is to concede the force of the arguments against axial rotation advanced by Tycho Brahe, and by many since.

XI. A very serious objection to Newton's postulate of universal attraction is the fact that its best friends are becoming sceptical concerning its truth. We have cited Professor Hall, Dr. Carl Neumann and Professor Seeliger on this subject. I may also mention an article by Kurt Laves, which he opens as follows:

"Certain phenomena in the motions of some of our planets have led astronomers to question the correctness of Newton's law of gravitation as a general law of nature. It is the purpose of this paper, first to point out those phenomena which cannot be explained from Newton's law, and second to give a short outline of the nature of those laws which have been proposed to replace that of Newton." *

The first of the inexplicable phenomena mentioned by Mr. Laves is the well-known difficulty in connection with Mercury. He declares that the discrepancy in the motion of this planet "of 41" between theory and observation cannot be explained in any way when we start from Newton's law of general attraction."

He continues:

"The other differences of the same nature which have been brought to light are those in the longitude of the perihelion of Mars, the longitude of the nodes of Venus and the famous secular acceleration of the motion of the Moon."

His statement of the laws proposed in substitution for that of Newton is technical, and so will not be reproduced here. He rejects that proposed by Professor Asaph Hall, on the following grounds:

"In the theory of the Moon the agreement between theory and observation would be spoiled. Besides there is no doubt that astronomers and physicists would be extremely slow in accepting a law which is made just to fit our present knowledge of existing discrepancies for a general law of gravitation in the manner indicated."

He continues:

"The other laws that have been proposed deserve more attention. They all have this in common that they consist of two parts, of which the first is the expression of Newton's law; the second, an additional term depending upon the time. These laws have been constructed in electro-dynamical theories and bear the name of their inventors. They are the laws of Gauss, Weber, Riemann and Clausius."

His discussion of them is too technical for any one not familiar with the mathematical expression of Newton's law. I will add his reference to Professor Seeliger's demonstration, and comment upon it:

"It is of interest to notice that Professor Seeliger has discussed the question

* "On Some Modern Attempts to Replace Newton's Law of Attraction by Other Laws," *Popular Astronomy*, February, 1898, pp. 513-18.

whether Newton's law of attraction can be regarded as a universal law of gravitation in a series of papers published in the *Astronomische Nachrichten* (Numbers 3287, 3292 and 3304), starting from an entirely different point of view than that outlined before.

"Professor Seeliger makes the assumption that the total mass of all the matter in the universe is infinite and then proves that if we apply Newton's law to the infinite universe we shall be led to contradictions. We have thus to assume either the one or the other of the following assumptions:

"1. The total mass of the universe is infinite and then we cannot regard Newton's law to be the rigorously exact expression for the attracting forces acting in it; or,

"2. Newton's law is rigorously correct and then we must conclude that infinite parts of the space *cannot* be filled with mass of *finite* density.

"It is certainly more logical to assume the first and regard Newton's law as an approximative formula which needs supplementary terms, the nature of which has not yet been ascertained."

XII. I cite another witness, Professor Simon Newcomb, one of the most eminent of mathematical astronomers now living. On the subject of the discrepancies between observed phenomena and Newtonian theory, he has recently written as follows:

"One of these deviations is in the rotation of the earth. Sometimes, for several years at a time, it seems to revolve a little faster, and then again a little slower. The changes are very slight; they can be detected only by the most laborious and refined methods; yet they must have a cause, and we should like to know what that cause is. The moon shows a similar irregularity of motion. For half a century, perhaps through a whole century, she will go around the earth a little ahead of her regular rate, and then for another half century or more she will fall behind. The changes are very small; they would never have been seen with the naked eye, yet they exist. What is their cause? Mathematicians have vainly spent years of study in trying to answer this question. The orbit of Mercury is found by observation to have a slight motion which mathematicians have vainly tried to explain.*"

XIII. I believe the secret of the approximate fitness of Newton's law to express mathematically the observed relations of the solar system is due to a fact which indicates that it is not a true law of nature: namely, that it is a hybrid between empiricism and a guess which will be pronounced fortunate or unfortunate, according to the point of view. That is to say, the guess was fortunate if we so esteem Newton's success in leaving a name which has since been upon every tongue, though at the cost of the propagation of error;

* Article, "The Unsolved Problems of Astronomy," *McClure's Magazine*, July, 1899. Some of the points discussed in this article were also touched upon in an address by Professor Newcomb, entitled, "The Problems of Astronomy," and printed in the Annual Report of the Smithsonian Institution for 1896.

while it was most unfortunate in view of the prosperity of this error, retarding the progress of more worthy investigation, and instilling false conceptions on moral questions of the greatest moment. The fact that Newton's law evidently expresses the equations of the solar mechanism with approximate accuracy is the reason given by Professor Newcomb, Professor Hall, and most others, for still believing that the postulate of universal attraction cannot be fundamentally false. But there is an explanation which appears to me to reconcile every fact in the case.

We must remember that Newton had Kepler's empirical laws before him—laws deduced from the well-nigh daily observations of Tycho Brahe, which had been carried on with remarkable accuracy through many years, and therefore gave a very close approximation to a true mathematical statement of the planetary motions about the sun. Were it not so, could Kepler's three laws have remained the practical basis of astronomical calculation to the present time?

For the sake of argument, let us assume that the electro-magnetic theory of heat, light and solar radiation is now demonstrated, and that now we all recognize electro-magnetism as the force which performs the offices in the solar system formerly assigned to universal attraction. The genesis of Newton's close guess at once becomes apparent.

In seeking a solution in the attraction the earth exerts upon all bodies on its surface, Newton was on the right track, for this terrestrial attraction is simply a manifestation of the electro-magnetism which we now assume to be the great force of nature. In extending the application of this attraction to the moon in his hypothesis, Newton made another correct deduction. But in failing to identify the earth's attraction as a form of magnetism, Newton missed his clue. For had he identified terrestrial attraction with magnetism, he could have experimented with magnets, would probably have discovered that their attraction is exerted inversely as the square of the distance, and so would have obtained this factor for his test with the Moon. But having missed this clue in a legitimate search, he unfortunately obtained the identical factor in an empirical way, which worked the mischief of enabling him to approximate the mathematical expression of the mechanical effect of the real force which controls the solar system, but in the interest of the postulate of a force which had no existence outside his imagination, which even to his own mind appeared to be a great absurdity, the postulate of which no rational philosopher could be guilty of falling into, and which is utterly irreconcilable with the observed mechanics of nature. The observations of Tycho Brahe, embodied in Kepler's laws, had revealed the fact that the velocities of the planets are not uniform throughout their orbits, but are rapidly accelerated as the planets approach the sun, while they diminish as the planets recede from the sun. Newton saw that this acceleration appeared to result from some influence of the sun, the power of which was about inversely as the square of the distance between sun and planet. Since he was to make a test to learn

whether the earth's attraction extended to the Moon, and since he also suspected that the secret of the relation of earth and Moon was also the secret of the relation between sun and planets, he applied this deduction from the acceleration of the velocities of the planets to his test with the moon. Thus Newton obtained a factor, based on actual observation of the mechanical operations of the electro-magnetism by means of which the sun controls the planets, as recorded by Tycho Brahe and formulated into laws by Kepler, and utilized this factor to give currency to a false and irrational postulate of an inconceivable force.

XIV. That Newton's law of gravitation is an empirical formula which is only approximately correct, has been evidenced from Newton's time to the present, in the fact that this formula has proven inaccurate in those cases where it can be most rigorously tested. If theory and observation cannot be shown to exactly coincide in the case of the Moon, then we cannot trust the appearance of coincidence in the case of the celestial bodies further removed. The Moon is the only celestial body whose distance can be measured by means of a base line drawn on the earth's surface, giving such a basis for the estimation of her size, volume and mass. Hence if discrepancy between theory and observation is found in the case of the Moon, where our observations are the most exact possible, it requires a strong bias in favor of theory to inspire confidence in the apparent harmony between theory and observation in the case of more remote bodies, since this appearance of harmony is probably due to the necessary imperfection of the testimony of the observations under such circumstances. We would be justified in this conclusion, even if the Moon afforded all the discrepancies. But what shall we say, when we reflect that the three celestial bodies, whose respective distances from us make them the most competent, after the Moon, to bear witness, namely, Mars, Venus and Mercury, are the very ones which also disclose discrepancies, while our own earth likewise fails to respond to theory in certain respects? Certainly great "faith" is required of the astronomers who in the face of such facts still esteem Newton's formula to be the exact mathematical expression of a great natural force!

XV. Granting that Newton's formula is an approximate expression of the action of electro-magnetism through space, and thus eliminating the "occult" paradox of gravitation, is it yet clear why Newton's formula is only an approximation? Perhaps not entirely; but it seems now certain that the omission of a time-element in Newton's formula is one source of error. Faraday long ago thought it inconceivable that a force like gravitation "acts without occupying time." To this was objected the mathematical demonstrations of Laplace and others, that gravitation *must* act instantaneously, since otherwise irregularities would occur which observation would readily detect. But the moment we substitute electro-magnetism for gravitation this objection appears to fall to the ground; for in this case the celestial bodies are controlled by a constant succession of wave-pulses from the sun, and since there is no inter-

mission in this succession, the effect produced is the same as would be that of instantaneously-acting gravitation, could we conceive of such a thing.

Hence the true solution of this problem would certainly seem to be in the line of the investigations of Faraday, Maxwell, Helmholtz, Hertz, Heaviside, Boltzmann and their fellow-laborers. As is well known, Hertz succeeded in producing electrical waves in the laboratory in 1888, at once demonstrating their finite velocity of propagation, and affording a powerful argument in favor of Maxwell's theory that light is simply one phase of electro-magnetic action. In view of this, Mr. Kurt Laves seems perfectly justified in saying that careful attention is due to attempts to reform Newton's formula by supplying a time-element deduced from electro-dynamical investigations. If it is possible to ascertain the velocity of electrical wave-propagation by means of experiments on the earth, this may solve the problem, and at the same time afford a new means of estimating the distances, sizes, volumes and masses in the solar system.

XVI. Yet not alone is Newtonian theory found wanting, but it is an undoubted fact that astronomers as a class have abandoned the Copernican hypothesis of the universe, as it was conceived by Copernicus, Gallileo, Kepler and Newton. The unrest long felt by astronomers on this score is perhaps illustrated by the following account of interviews with German astronomers:

"One who doubted the possibility of the Copernican system desired to be enlightened about it, and went to Alexander v. Humboldt, who was indeed ever the first refuge of those seeking information, and was, too, so com-pleasant that he sent nobody away, that he even conscientiously answered each letter. The visitor was friendly [*sic*] received by Alexander v. Humboldt, and when he laid before him his doubt about the Copernican system, got for answer the memorable words: 'I have known, too, for a long time, that we have no arguments for the Copernican system, but I shall never dare to be the first to attack it. Don't rush into the wasps' nest. You will but bring upon yourself the scorn of the thoughtless multitude. If once a famous astronomer arises against the present conception, I will communicate, too, my observations; but to come forth as the first against opinions which the world has become fond of—I don't feel the courage.'

"From Humboldt our doubter went to Encke. Here, indeed, he was not friendly received. In a surly manner Encke declared that astronomers had something better to do than to meddle with hypotheses; he had no time to teach every one who had any doubts; there were books enough about astronomy—these he should read. The doubter replied that he had already read the books written for the general public by Littrow and Mädler, but he had found in them no reliable information. Encke remarked on that, that if these books did not satisfy him, he, too, could not give him further advice.

"In 1854 our doubter visited Carl v. Raumer at Erlangen, who avowed

to him openly that he, too, was not fond of the Copernican hypothesis, but had never dared do more than utter vague objections against it. Thus in his 'Croisades,' p. 119, where he writes: 'Now, indeed, each school-master, according to hearsay, teaches that the earth moves round the sun, without thinking in the least about exerting himself and his scholars to perceive the planetary movement.' When the doubter left Raumer, the latter congratulated him on his purpose of helping truth to her rights; he was, however, doubtful whether it would in a short time be possible to vanquish the fanaticism of the world.

"At Munich our doubter visited Lamont, director of the observatory. Lamont said to him: 'You and the world in general are in error; never yet has any real astronomer spoken of a Copernican system; we only know a Copernican hypothesis. Whether this may be true or erroneous does not matter at all for each genuine astronomer.' The doubter replied that he knew very well, but then surely one should not abandon lay people to the presumption that astronomy takes the Copernican hypothesis for a truth. 'I have never meddled with lay astronomy,' said Lamont, 'if Littrow and Mädler instil superstition into the people by selling hypothesis for truth, that is their affair.'

"At Göttingen our doubter made the acquaintance of the astronomer Gauss, who met him in the most friendly manner, aided him with books and allowed him to apply to him at each time when he thought himself to have need of his counsel. The doubter communicated to Gauss the course of his investigations made hitherto; he told him of his having found that all the great thinkers, such as Schelling and Hegel, had criticised the transcendent suppositions of the Copernicans, while only little spirits and uneducated folk claimed the right of not only scorning as a fool, but even persecuting with wild fanaticism, him who did not agree with the chorus of general opinion. Gauss avowed to the doubter that every new discovery in astronomy filled him with new doubts about the dominant system. When our doubter communicated to him that Alexander v. Humboldt had declared he would likewise arise immediately against the present conception, if some famous astronomer would declare himself against the dominant system, Gauss answered: 'Aye, if I were twenty years younger!'

"The astronomers of our days [1885] say: Everybody will understand that an astronomer of the present time cannot take up any other system than that of Copernicus, though it were but by way of trial. They assert that the system of Copernicus is the only possible one, the eternal foundation of all further progress of astronomy, that with the system of Copernicus the whole of astronomy stands or falls, and that without it we must renounce all explanation, all scientifically founded prediction." *

VII. Although orthodox astronomers now generally concede the main

* "The Fixed Idea of Astronomical Theory," by August Tischner. Leipzig, 1885, pp. 33-35.

point advanced by Mr. Tischner against the Copernican hypothesis, the statement of the case by Mr. Tischner may help any one who is not familiar with the nature of the difficulty to a better conception. In the "Introduction" to the tract from which we have cited, he says :

"It was as an explanation of the phenomena of heaven that the theory of a fixed earth in the centre of the universe was stated; this theory was found to be untenable, when the movement of the earth was recognized, and now theory based itself on a fixed sun. But afterwards it was discovered that even the sun is not fixed, but transposes himself in space. The conviction, too, was arrived at that not only the sun moves in mundane space, but also that the stars, too, are not fixed, but in motion. In short, in the universe there is no immovable thing, neither a fixed earth, nor a fixed sun, nor fixed stars. Now, instead of stating or seeking some theory based upon the general movement of all the heavenly bodies, mankind has become so enamored of the idea of a fixed sun, that no astronomer has the courage to come forward in order to demonstrate that the present conception of the universe is no longer tenable. They have even dared to affirm, that it is quite irrelevant to theory whether the sun is considered as fixed or as in motion; for astronomers say, 'we may consider the sun as being at rest.'"

If Mr. Tischner can be justified in criticising astronomers for clinging to a hypothesis which they have themselves ceased to credit, he certainly cannot be for insinuating that "mankind has become so enamored" of this conception that astronomers have not had the courage to expose the error. Where did the "little spirits and uneducated folk," of whom Mr. Tischner complains, obtain the basis for "the chorus of general opinion" as to the system of the physical universe? From the astronomical priesthood, who industriously have inculcated the opinion that astronomical orthodoxy was long ago established on a basis of mathematical infallibility, so that the Bible, or any other venerable authority which should seem to conflict with astronomical dogma, is necessarily impeached! It is a very pretty tale that fear of mankind—of the "little spirits and uneducated folk"—has withheld astronomers from the exposure of the groundlessness of the popular belief in astronomical infallibility! Astronomers have been slow to expose themselves and their boasted "science"! They have been reluctant to resign the honor of their undisputed occupancy of Moses' seat, and have not made haste in making plain that they have secured this authoritative sway over the popular mind by an assumption of infallibility which is as great an imposture as any practiced by religious priesthood in its worst phases!

Again, Mr. Tischner does not recognize that the failure of Copernican hypothesis may indicate that a return to the theory of a "fixed earth," on the Biblical-Tychonic basis, is far more rational than the unproven postulate of the translation of our solar system through space, which he

maintains, with the modern astronomers. His account of that translation, on the basis of an enormous orbit, is that which the astronomers were inclined to give until recently. Mr. Tischenr says :

"The sun, eternally moving in the universe, carries with him his system, the planets, &c.; none of the appertaining bodies can remain behind, all must follow the sun with the same velocity, without regard to their circulation [orbital revolution], without regard to their own movement. While the planets are following the sun, they make curves of revolution. The sun advancing, no planet can precede or move in front of him in his path or orbit. If the sun is moving, there are no closed orbits re-entering into themselves, nor planes of orbits. The moving sun changes the orbits (curves of revolution) of the planets following him into spirals; the ring of the spiral is therefore the true curve of revolution of the celestial body, which it describes by its own velocity; the curve centrally seen is a circle; the consecutive rings will therefore exhibit a series of revolutions as a cylindrical spiral.

"What immense space of time is required to determine the motion of the sun and stars! Already observations are showing us these motions; they seem, upon the whole, to indicate a general movement of all bodies belonging to the solar system towards the constellation of Hercules; but they seem to demonstrate, too, that the apparent motion of the stars is a combination of their own movement with that of the sun.

"The fact is that the planets do not revolve round the sun, but follow him. It is evident that the revolution is related to the sun and his centre; but in truth they proceed round the orbit of the sun. The moon, for example, moves with the earth in the same direction.

"While the planets describe their original curve, they are drawn forward by the sun; the consequence of which is the inevitable necessity for the spiral as the definitive curve of orbit or moving line of double curvature, which results from the combination of two velocities (forces), one of which belongs to the planets, being their originally received velocity which they themselves cannot change; the other belongs to the sun. It is this movement of the sun which is communicated to the planets by attraction; their own velocity receives by it an increment which may be called leading or conducting velocity. The sum of both movements is the absolute velocity of the planet in space. What is understood of the sun and planets, may be said likewise of the planets and their satellites. It is, therefore, the original circular motion of the planets, modified by the motion of the sun, which may be taken to be the path of their orbit, and the figure of which we have considered as a ring changed into an endless spiral.

"The first consequence of the movement of the sun delivers astronomical theory from a great burden; it no longer needs centrifugal force.

"After the sun, who is like the nucleus of a comet preceding it, there come, ranged one after another, the planets, the curves of revolution of which

enlarge more and more according to their distance, as if they represented so many centrifugal pendula, the threads of which proceed from the centre of the sun. If all these are in revolution and the sun is, for a moment, considered as immovable, the threads (*radii vectores*) form regular cones, the base of which is perpendicular to their axis. The circumference of this base of the cone is what we have called the original curve of revolution. If these cones are situated in the same angle, they seem to make but a single one, the planets revolving on the surface of it. To judge from observation, it seems indeed that the cones are situated nearly in the same angle. . . . Now, if the sun moves, the direction of his movement is the common axis of the cone, that is to say, the planets revolve round the line described by the sun, which we may call his orbit; this line is the very equator of heaven.

"It is clear in itself, that the sun moves in a curve. . . . According to this view, the cone, the figure of the system, will require a slight curvature and give an image which reminds us of the figure of the horn of plenty." *

XVIII. This explanation of the translation of the solar system through space involves the postulate that the sun is carrying his system through the heavens along the circuit of some immense orbit, "the very equator of heaven," about the real centre of the physical universe. The inference is that the other suns, the fixed stars, with their systems, are moving in enormous orbits about the same centre of the universe. This dream has been nursed by Kant, Swedenborg, and other visionaries. But the observations which have forced astronomers, imbued with Copernican notions, to postulate the translation of our solar system through space, now lead them to conceive of this movement as one element of a general anarchy which prevails among the celestial bodies, whereby the innumerable systems are flying from one another in straight lines, the ultimate result being that our solar system will be left alone, moving through a starless sky! Professor Simon Newcomb has very recently expressed this view, as follows:

"Now, the greatest fact which modern science has brought to light is that our whole solar system, including the sun, is on a journey toward the constellation Lyra. . . . The speed has recently been determined with a fair degree of certainty, though not with entire exactness; it is about ten miles a second, and therefore not far from three hundred millions of miles a year. . . .

"So far as we can yet see, each star is going straight ahead on its own journey, without regard to its neighbors, if other stars can be so called. Is each describing some vast orbit which, though looking like a straight line during the short period of our observation, will really be seen to curve after ten thousand or a hundred thousand years, or will it go straight on forever? If the laws of motion are true for all space and all time, as we are forced to believe, then each moving star will go on in an unbending line forever unless

* *Ibid.*, pp. 15-22.

hindered by the attraction of other stars. If they go on thus, they must, after countless years, scatter in all directions, so that the inhabitants of each shall see only a black, starless sky. . . .

"Mathematical science can throw only a few glimmers of light on the questions thus suggested. From what little we know of the masses, distances and numbers of the stars, we see a possibility that the more slow-moving ones may, in long ages, be stopped in their onward courses or brought into orbits of some sort by the attraction of their millions of fellows. But it is hard to admit even this possibility in the case of the swift-moving ones. Attraction, varying inversely as the square of the distance, diminishes so rapidly that, at the distances which separate the stars, it is small indeed. We could not, with the most delicate balance that science has yet invented, even show the attraction of the greatest known star. So far as we know, the two swiftest-moving stars are, first, Arcturus, and second, one known in astronomy as 1830 Groombridge, the latter so called because it was first observed by the astronomer Groombridge, and is numbered 1830 in his catalogue of stars. If our determinations of the distances of these bodies are to be relied on, the velocity of their motion cannot be much less than 200 miles a second. They would make the circuit of the earth every two or three minutes. A body massive enough to control this motion would throw a large part of the universe into disorder. Thus the problem where these stars came from and where they are going is for us insoluble, and is all the more so from the fact that they are moving in different directions and seem to have no connection with each other or with any known star." *

XIX. Thus Professor Newcomb's explanation of the solar system plainly concedes the main contention of Mr. Tischner, except that Professor Newcomb thinks probability favors a straight line as the direction of the sun's course, in place of the slightly curved orbit suggested by Mr. Tischner. But all such conclusions, whatever may be their minor differences, involve weighty corollaries which our astronomers seem slow to recognize, probably because their minds are wholly pre-occupied with the prejudiced view of things engendered by education in Newtonian-Copernican doctrine. He who cannot free his mind absolutely from this bias, will remain under a serious handicap in surveying the present nebulous condition of theoretical astronomy. And on this account it may very readily happen that the most valuable suggestions toward a more rational reconstruction of astronomical theory will come from those who are not professional astronomers, independence of mind and freedom from bias more than compensating for expert technical knowledge. In the same way, the attempted discussion of these subjects even by a tyro like myself, since it is done in a thoroughly skeptical spirit, may serve to call attention to the completeness

* "The Unsolved Problems of Astronomy," *McClure's Magazine*, July, 1899.

of the collapse of the entire theoretical branch of astronomical science, inducing some independent minds to meditate upon the subject. Astronomers themselves certainly seem as helpless as they have often declared theologians to be.

It requires a little care to realize the quandary in which the modern astronomer is placed. The problem before him is that of steering a course between Scylla and Charybdis. It seems absurd, on the one hand, to apply to the mechanism of a system, whose controlling sun is conducting his planetary satellites swiftly through space, the explanations framed for a system whose controlling sun was considered practically fixed in space, holding his satellites in elliptical orbits, one outside the other, about himself as their common centre. Every one knows that the laws of Kepler and the hypothesis of Newton, with the mathematical solutions developed by Newton, Lagrange, Laplace, Adams and Leverrier, are all in explanation of the mechanism which would result from a fixed sun, holding in equilibrium about himself planets moving in elliptical orbits which practically re-enter themselves with every revolution of the respective planets. To pretend that we would expect this result were the sun speeding through space with a velocity ranging from three to eighteen miles per second, is the Scylla which every astronomer must necessarily avoid. On the other hand, if the laws of Kepler are quite false, representing appearances but not facts, and if Newton's law is out of the question as applicable to the actual mechanism of the solar system, how comes it that coincidence between theory and observation has been so closely approximated on this basis, while the current formulas have served as a basis for prediction which is approximately correct, so far as our present means of observation permit us to judge? Granting that the postulate of gravitation is untenable, and that Newton's law is empirical, having been formed by a guess based on observations, yet if the solar system be not controlled by *some* force which maintains order and equilibrium, and if Newton's law does not very closely approximate the mathematical expression of the operations of this force, how comes it that observations of Uranus, compared with this law, indicated the existence of another planet, and that this disturbance of Uranus, accounted for on the basis of Newton's law, enabled Adams and Leverrier to tell astronomers about where to turn their telescopes in order to find the planet Neptune? Of course this famous case of prediction did not establish the postulate of gravitation, as even some astronomers have carelessly asserted; nor yet demonstrate that Newton's law is the *exact* mathematical expression of the great force of nature operating the celestial mechanism. But can the empiricism which yields such a result be out of all proportion to the actual facts of nature? This is the Charybdis which threatens with shipwreck any astronomer who despises the empirical conclusions based on the hypothesis of a fixed sun! If it can be shown that the Biblical-Tychonic system apparently reconciles all the factors in this strange

problem, will it not be admitted that this fact alone entitles that system to serious consideration, despite its seeming absurdity to the Copernican prepossession which is so accustomed to soar into infinity, and despite the fact that consideration of this system might tend to restore that confidence in the Bible which astronomers as a class have labored so zealously to destroy? That the Biblical-Tychonic system would render a rational explanation in the premises, I will undertake to show in a moment. Here we may briefly state the problem.

Observations which have been carefully registered for many years show that the fixed stars, so-called, seem gradually moving apart in one part of the heavens, while in the opposite part they seem gradually to be coming together. On the Copernican postulate, this would certainly seem to indicate a swift movement of our solar system toward the part of the heavens where the stars appear to be moving apart. Some assert that this translation through space is directly towards the constellation of Hercules, others that it is toward the constellation of Lyra. Professor Vogel has variously estimated the velocity of this motion as between three and ten miles per second. Professor Newcomb, as we have seen, estimates it at ten miles per second. Weighing different opinions, Mr. Fison thinks it is "probably between twelve and eighteen miles per second."*

The orbital velocity assigned to the earth during her annual revolution about the sun, on the Newtonian-Copernican hypothesis of a fixed sun, is about nineteen miles per second; while in addition to this motion, and to her daily rotation, we are now to credit her with a forward velocity through space which is one-half her orbital velocity, or more. In the case of the Moon, this translation through space is to be taken into account, together with the Moon's velocity in her own orbit about the earth, and her much greater velocity in moving with the earth in the orbital revolution about the sun. Now if the planets are controlled by the attraction of the sun, as astronomers suppose, and the translation through space be a fact, it seems irrational to conceive of the solar system on any other basis than the conical-spiral formation suggested by Mr. Tischner. Yet to conceive of it on this basis involves, (1) the complete collapse of nearly all the current estimates of astronomy, and (2) the contradiction of observations.

The sun has been estimated to be about 853,000 miles in diameter, while its mean distance from the earth is about 93,000,000 miles. These estimates are based upon observations of the opposition of Mars and of the transit of Venus. The method employed in the case of Mars is not decisive for one who questions the truth of the Copernican hypothesis and doubts the reality of the earth's alleged diurnal rotation; while astronomers concede that observations of the transit of Venus have so far yielded no reliable result. But granting that the distance between the sun and the

* "Recent Advances in Astronomy," by Alfred H. Fison. London, 1898, p. 47.

earth is known to be about 93,000,000 miles, what is involved in the conical-spiral conception of the solar system? The present estimate of the earth's orbit of revolution becomes worthless! This estimate is very simply obtained by doubling the distance between earth and sun, which gives 186,000,000 miles as the mean diameter of the earth's orbit. But the moment we consider the conical-spiral formation, we at once see that the distance between earth and sun is not the radius of a closed orbit about a fixed sun, but the slant height of a cone, the base of which may be conveniently—but not accurately—considered as circumscribed by the orbit of the earth. (In truth, the orbit would be an endless spiral; but the diameter of the base of the cone would give the diameter of the spiral thus formed, and suffices for illustration.) On this supposition, it is absolutely useless to speculate as to the orbit of the earth, unless astronomers can find some means of determining the altitude of the cone thus described. To make the conception more simple, let us consider the cone as cut in two, from apex to base, and deal with the plane surface thus exposed to view. We thus have an isosceles triangle, the sun being at its apex, its two equal sides being each measured by the distance between the sun and the earth, while its base would be the diameter of the spiral described by the earth's orbit. The natural idea of the effect of the sun's swift sweep through space with his planets trailing behind, reinforced perhaps by the appearance of the tails of comets and meteorites, would lead us to conceive of the base of our triangle, representing the approximate diameter of the earth's orbit, as much shorter than the equal sides, representing the distance between the sun and the earth. Instead of estimating the *radius* of the earth's orbit at 93,000,000 miles, we would consider that too much even for the *diameter* of the earth's orbit! And down would go all the estimates hanging upon the present postulate of aberration of light and the supposed velocity of light, measured on the assumption that the mean diameter of the earth's orbit is about 186,000,000 miles! Down would fall all the estimates based upon planetary parallax and stellar parallax—all our conception of sizes, distances and velocities, as applied to the so-called fixed stars, dwindling materially! We could no longer estimate the various planetary relations as if all the planetary orbits lay in practically the same plane, one outside the other, but must estimate all the relations on the conical-spiral hypothesis, the distance between the sun and each planet being the slant height of a cone the diameter of whose base would be the approximate diameter of the planetary orbit, instead of the distance between the sun and planet giving the mere radius of an elliptical orbit!

But on the other hand, what astronomer dares allow this natural and rational effect of the sun's conveyance swiftly through space of a band of satellites? At the first glance, the conical-spiral postulate appears to fall into the same condemnation as Ptolemy's hypothesis, as hopelessly contradicting our observations of Venus and Mercury. On the postulate he pre-

sents, how would Mr. Tischner explain the eclipse of these planets by the sun?

If astronomers retain their Copernican ideas, and seek to adjust a modification of the Copernican hypothesis to the postulate of solar translation through space, I can conceive of but one formation which could be thought less irrational than that taught in the books, while equally representing the observed phenomena and accounting for the approximate success of prediction on the basis of Kepler's laws and Newton's formula. We must consider all the planets as moving about the sun in what would be elliptical orbits, one outside the other, in nearly one plane as in present theory were there no translation through space, and all moving through space without trailing behind the sun, forming spiral orbits with one diameter perpendicular to the line of the sun's path through space. With this conception, we would no longer speak of the planets as moving sometimes above and sometimes below the plane of the ecliptic, but as moving sometimes before and sometimes behind it. Were space a vacuum, on the basis of Galileo's laws of motion we might perhaps conceive of such a solar-planetary vortex, projecting itself through space and revolving about the centre of its path as the axis of the system. But the postulate of a resisting medium, now entertained by scientists, would seem to render this conception as absurd as that of the sun sweeping through space accompanied by satellites moving about him in orbits in the plane of his path, and thus passing in front of him. Even on the basis of a fixed sun it has been considered probable that a resisting medium in space is gradually diminishing the velocity of the planets, so that they yield more and more to the attracting force of the sun, are slowly approaching him in gradually-narrowing orbits, and must eventually fall into the sun. But with modifications of the Copernican hypothesis to meet the postulate of translation through space,—whether we consider the plane of the ecliptic to lie in the plane of the path of the system through space, or adopt the other alternative,—we must postulate an additional action of the resisting medium upon the planets, tending to make them trail behind the sun, as the comet's tail trails behind the nucleus. Observation, however, shows the contrary of this—the planets sometimes preceding the sun; revealing no effect of a resisting medium, providing there is translation through space.

In addition to the five points under this head already made, I add a few other arguments in favor of the Biblical-Tychonic theory,

VI. The Biblical-Tychonic theory avoids all the difficulties attendant upon a postulate of the translation of the solar system through space. According to this hypothesis, the celestial sphere is a related whole, as it phenomenally appears to be, with a daily rotation about the earth; hence the appearance of stars drawing apart in one section of the heavens and drawing together in

the opposite section is to be referred wholly to a very slight movement of the star-relations, and neither indicates a translation of the solar system through space, nor a general condition of celestial anarchy.*

VII. While the inconceivable distances required by the Copernican postulate, projected by the imagination to help out the hypothesis, were deemed the best of reasons for rejecting a conception making demands so lavish upon pure fancy, by men of intellect like Tycho Brahe, Sir Francis Bacon, Shakespeare and Milton, together with the consensus of popular opinion in their day, in the present day the educational bias is so different that the true system of the physical universe (whatever it may be) would inevitably appear grotesque, if it failed to appeal to the imagination on some immense scale. What are the elements which describe the most rational astronomical hypothesis, *per se*? Let us suppose that the jury to whom we put this question embraces both the generation of Bacon's day and that of the present day, while we have induced the one to carefully guard against the influence of prejudices engendered by educational bias favoring Ptolemaic theory, and have induced the other to guard against prejudices engendered by educational bias favoring the Copernican theory. What would be the answer to the question? Perhaps something like the following: The most rational astronomical hypothesis, *per se*, is that which embraces the observed relations the most comprehensively and explains them most simply, on the basis of the mechanics of nature known to us on the earth, requiring the least amount of inventions unsuggested by the observed phenomena and contrived to meet the exigencies of theory, and making the least demand upon us to credit the marvellous. Let us compare the Copernican and Biblical-Tychonic hypotheses by this rule.

If the postulate of universal attraction be true, then we must concede that the Copernican hypothesis, with one great centre of attraction, is even more simple than the Biblical-Tychonic hypothesis, with two great centres of attraction.

If we call in question the postulate of universal attraction, the advantage is with the other side. And to believe in gravitation, we must postulate the mysterious, the marvellous, the absurd—an anomaly in nature;

* We must not forget that the displacements among the fixed stars are scarcely discernable after centuries of observation. It is only the Copernican conception of vast distances which compels us to interpret these exceedingly minute displacements as evidences of swift translations through space. Thus in the article from which we cited, and when speaking of the two stars whose velocities appear to be the greatest, Prof. Newcomb says: "It must not be supposed that these enormous velocities seem so to us. Not one of them, even the greatest, would be visible to the naked eye until after years of watching . . . To the oldest Assyrian priests Lyra looked much as it does to us to-day. Among the bright and well-known stars Arcturus has the most rapid apparent motion, yet Job himself would not to-day see that its position had changed, unless he had noted it with more exactness than any astronomer of his time." On the Biblical-Tychonic basis, these displacements may be themselves trivial, and their significance equally so.

while, on the other hand, we no longer recognize the device of two attracting centres where one would do, but perceive the arrangement for a huge celestial electro-dynamic machine, which produces the related phenomena of heat, light, chemical energy, electricity and magnetism.

In ability to account for the essential observed phenomena, each hypothesis is the peer of the other. If we accept terrestrial gravitation as a sample of universal attraction, we must also concede that both hypotheses are on an equality in ability to explain the observed relations "on the basis of the mechanics of nature known to us on the earth."

The Biblical-Tychonic theory, explained on the electro-magnetic basis, has a remarkable advantage over the other in point of simplicity and ability to explain more of the phenomena of the solar system; for while gravitation accounts for the relations between the members of the solar system, and for the phenomena of falling bodies, electro-magnetism not only accounts for both these things, but enables us to recognize that the same force which holds the orbs together supplies light, heat, actinic energy and electrical energy throughout the system.

The hypotheses are on a par in extending to the entire physical universe the operation of the respective forces assigned to control the solar system; but the Biblical-Tychonic theory here retains its advantage, by being also able to extend to the entire physical universe its ability to explain the most phenomena by the postulate of a single force.

The Biblical-Tychonic theory has a great advantage in simplicity and credibility in virtue of explaining the entire physical universe as one closely-related and orderly system; whereas the Copernican hypothesis represents the solar system as isolated, in independence of the rest of the physical universe, with the suggestion of many other independent systems.

The Copernican hypothesis requires the pure assumption that the so-called fixed stars are great suns, launched in space, at an almost inconceivable distance from us. This supposition, as is well known, is wholly gratuitous; was not suggested by observations; but is simply a marvellous invention of the imagination, compelled by the exigencies of the hypothesis. The fact that the necessity of making this assumption was long the most serious obstacle in the way of the acceptance of the Copernican hypothesis, shows how contrary the assumption is to the natural inference from observations. The Biblical-Tychonic theory does not tax credulity and pure imagination with any such invention, leaving the question of distances here to be independently determined by scientific investigation.

Finally, the Copernican hypothesis is now laden with the marvellous postulate that immense systems, at inconceivable distances, are rushing through unthinkable spaces, with incredible velocity, and without apparent law or order! The Biblical-Tychonic theory makes no such demand upon human "faith" and imagination!

Hence if the Copernican hypothesis is the more rational, then Hume's

philosophy breaks down, and instead of requiring faith to believe in miracles, the miracles in the Bible are the very thing which ought to recommend it to the human reason—just as the miracles and marvels of Copernican hypothesis are marks of superiority over a system which requires us to postulate nothing concerning which we have no evidence! How logical and consistent are the mental processes of materialistic scientists!

Is it any thing but educational bias which could think it a point against the credibility of a system, instead of a point in its favor, that it should conceive of the physical universe, however vast, as yet finite? If so, even the Copernican system is now likely to come under this reproach, as witness these words of Professor Simon Newcomb:

"Another unsolved problem among the greatest which present themselves to the astronomer is that of the size of the universe of stars. In other words, has the universe a boundary? . . . It is a great encouragement to the astronomer that, although he cannot yet set any exact boundary to this universe of ours, he is gathering faint indications that it has a boundary, which his successors not many generations hence may locate so that the astronomer shall include creation itself within his mental grasp. It can be shown mathematically that an infinitely extended system of stars would fill the heavens with a blaze of light like that of the noonday sun. As no such effect is produced, it may be concluded that the universe has a boundary." *

Evidently this last is Professor Newcomb's deduction from the problem of Professor Seeliger, referred to above. But granting that the universe is finite, the darkness of the interstellar spaces remains one of the best of reasons for doubting that the stars are suns, and for believing that they are smaller bodies raised to incandescence by the electrical wave-pulses from our sun.

VIII. The Biblical-Tychonic theory is strengthened by the fact that, spite of the current hypothesis, observations certainly show our earth to be situated apparently at the centre of the physical universe. Before introducing testimony to this effect, let us note the following, as an example of the arguments against the probability that God would really reveal Himself to the earth, as Scripture teaches, which are frequently founded upon the assumption of the infallibility of Copernican theory:

"Before the powerful mind of Copernicus ventured to question it, our earth was held to be the centre of the universe, and about it all the rest of the heavenly bodies revolved. There was but one 'world,' and that was our earth; the whole firmament, infinitely, was the fitting frame to the picture, upon which man, as the most perfect being, held a position which was truly sublime. . . . It was an elevating thought that you were on the centre, the only fixed point amidst countless revolving orbs! The narrations in the Bible, and the character of the Christian religion as a whole, fitted this conception exceedingly well; or, more properly speak-

* *McClure's Magazine*, July, 1899.

ing, were made to fit it. The creation of man, his fall, the flood, and our second venerable ancestor, Noah, with his ark in which the continuation of races was provided for, the foundation of the Christian religion, the work of redemption; all this could only lay claim to universal importance so long as the earth was the centre of the universe, the only world. Then all at once a learned man makes the annihilating assertion that our world was not the centre of the universe." *

Even the Christian who concedes the Copernican conception as the true one, may justly reply to such an argument, as has been done:

"God has been pleased to connect Himself in a special way with man in all these things; marvellous privilege of His feeble creature! Philosophy—senseless, narrow-minded, and even essentially stupid in its arguments—would have it that the world is too small for God thus to expend Himself on an impotent being like man, on that which is but a mere point in an immense universe. Contemptible folly! As if the material extent of the theatre were the measure of the moral manifestations wrought upon it, and of the war of principles which is there brought to an issue. That which takes place in this world is the spectacle that unfolds to all the intelligences of the Universe the ways, and the character, and the will of God." †

Yet, whatever may be the scale of sizes and distances in the physical universe, it is perfectly plain that the Mosaic account of creation, as creation was finally prepared for the advent of man, represents sun, moon and stars as placed in the firmament with special reference to the earth, as witnesses of God's glory and goodness to man. And spite of the fertile imagination of modern star-gazers, the stubborn fact remains that our insignificant earth appears to be the centre even of the vast infinity of starry space which Copernican theorists postulate. Here again I cite Professor Newcomb's recent article:

"The number of new stars brought out with our greatest power, is vastly greater in the Milky Way than in the rest of the sky. . . . What is yet more curious, spectroscopic research has shown that a particular kind of stars, those formed of heated gas, are yet more condensed in the central circle of this band; if they were visible to the naked eye, we should see them encircling the heavens as a narrow girdle, forming perhaps the base of our whole system of stars. . . . A most curious fact is that our solar system seems to be in the centre of this galactic universe, because the Milky Way divides the heavens into two equal parts, and seems equally broad at all points." ‡

IX. Geology suggests what may be a powerful argument in favor of the

* "Galileo Galilei and the Roman Curia," by Karl von Gebler (Eng. trans.) London, 1879, p. 14.

† "Synopsis of the Books of the Bible," by J. N. Darby (new edition). New York: Loizeaux Bros., vol. iii., p. 15.

‡ *McClure's Magazine*, July, 1899.

Biblical-Tychonic theory, in predicating extensive glacial phenomena on the earth's surface at a recent geological period. The nebular hypothesis of astronomy supposes that all matter in the solar system was once a luminous cloud, rotating about its centre of gravity, toward which there was a slow condensation of the mass. In this process, successive rings were thrown off, which concentrated into globes, forming the planets and their satellites, these masses becoming solidified as they cooled. But this hypothesis necessitates the postulate that the heat of the sun was much more intense formerly than now, that it is gradually diminishing, and that the great solar furnace which heats and lights our planetary system will eventually become extinct. Yet in the recent article from which we have several times quoted, Professor Newcomb declares: "What we can say with confidence is that observations of temperature in various countries for the last two or three hundred years do not show any change in climate which can be attributed to a variation in the amount of heat received from the sun."

Thus the current astronomical conception requires the supposition that there has been a gradual diminution of light and heat throughout the solar system, from the nebulous period to the present time; whereas observations during the time that man has recorded them give no countenance to the theory. On the other hand, geological science requires another hypothesis: (1) The prolific animal and vegetable life during the early geological ages would seem to indicate a solar energy in the primeval ages greater than that displayed within the memory of man; (2) the termination of the early prolific period by catastrophe is apparently indicated, involving the submergence of the earth beneath water and ice; (3) from these conditions the earth emerged practically as since known to man. Therefore the Biblical-Tychonic theory has the great advantage over the nebular theory of exact agreement with the testimony of the geological formations.

According to this theory, the original creation of the heavens and the earth, mentioned in Gen. i. 1, gives the origin of the earliest geological age. Whether the long pre-glacial ages which followed were intended by God as a series of object-lessons for angelic intelligences, we cannot say. In Gen. i. 2 we have the recognition of the cataclysmic condition which followed these periods. All forms of life had become extinct, since the earth had become "waste and empty." That the earth was submerged, is shown by the reference to "the face of the deep" in this verse, and to the fact that verse 9 records that the dry land of earth was subsequently made to emerge from the waters. That the catastrophe had also deranged the great electromagnetic engine of the celestial vault, is indicated by the statement in verse 2 that "darkness was upon the face of the deep," by the fact that light had subsequently to be invoked by God's fiat, as recorded in verse 3, and by the fact that God's fiat re-established sun, moon and stars as light-bearers (Gen. i. 14-18). Since the withdrawal of light from the solar system during this catastrophe involved the withdrawal of heat, the glacial phenomena are

rationally explained. Following this catastrophe, we have the six days' work mentioned in Gen. i. 3-31, by means of which the physical universe was re-constructed substantially as it has since appeared to man.

X. As a final argument under this head I submit another citation from Professor Newcomb's article, to show that the electro-magnetic theory of solar energy agrees well with observations, so far as our present methods enable astronomers to judge. Speaking of the sun, Professor Newcomb says :

"There are several mysteries which ingenious men have tried to explain, but they cannot prove their explanations to be correct. One is the cause and nature of the spots. Another is that the shining surface of the sun, the 'photosphere,' as it is technically called, seems so calm and quiet while forces are acting within it of a magnitude quite beyond our conception. Flames in which our earth and everything on it would be engulfed like a boy's marble in a blacksmith's forge are continually shooting up to a height of tens of thousands of miles. One would suppose that internal forces capable of doing this would break the surface up into billows of fire a thousand miles high ; but we see nothing of the kind. The surface of the sun seems almost as placid as a lake. Yet another mystery is the corona of the sun. This is something we should never have known to exist if the sun were not sometimes totally eclipsed by the dark body of the moon. On these rare occasions the sun is seen to be surrounded by a halo of soft white light, sending out rays in various directions to great distances. This halo is called the corona, and has been most industriously studied and photographed during nearly every total eclipse for thirty years. . . . It has a fibrous, woolly structure, a little like the loose end of a much worn hempen rope. A certain resemblance has been seen between the form of these seeming fibres and that of the lines in which iron filings arrange themselves when sprinkled on paper over a magnet. It has hence been inferred that the sun has magnetic properties, a conclusion which, in a general way, is supported by many other facts."

I may add that my interest in this subject is not at all that of one who has a pet astronomical hypothesis to promote, but of one who prefers the Bible to the dictum of peccable scientists on any and every subject to which Scripture refers, and where it can be shown that the current scientific orthodoxy impeaches the Bible, if its conclusions be allowed. I am as sceptical respecting the inerrancy of scientific dogma, wherever it conflicts with Scripture, as any scientist can well be respecting Scriptural dogma. To show how justifiable my position is, I have attacked, with a few poorly-digested points, not the weakest point in current scientific theory, but the hypothesis considered impregnable. It is the notorious fact that astronomical theory, with its claim of infallibility on the basis of alleged mathematical demonstration, has

been the great weapon wherewith the scientist, during the last two centuries, has ousted theology from Moses' seat, usurping the reins of authority over the human mind. So complete has been the surrender to the scientific priesthood and hierarchy, that Protestants (from whom, at least, we might have expected better things) have characteristically abandoned confidence in Scripture, as a divinely inspired and infallible revelation, to take up with abject confidence in scientific pretension, so that with many, even among those who still cling to a profession of Christianity, the Scriptures are no longer credible in so far as they venture to conflict with even the most ephemeral scientific assertion in any quarter! Yet I have not a doubt that the Christian who takes Scripture as an infallible guide (studying it carefully and prayerfully, and seeking to avoid the mistake of rejecting scientific postulates hastily, where the seeming contradiction is not real), will find his Bible to be the true "royal road to learning" in all branches of science, enabling him to take forth the precious from the vile, and to detect irrational hypotheses and unnatural deductions. The necessity for some such touchstone, in testing the immense mass of ore thrown up by modern scientists, is indicated by the following remarks of Dr. Karl Pearson:

"It might be supposed that science has made such strides in the last two centuries, and notably in the last fifty years, that we might look forward to a day when its work would be practically accomplished. At the beginning of this century it was possible for an Alexander von Humboldt to take a survey in the entire domain of then extant science. Such a survey would be impossible for any scientist now, even if gifted with more than Humboldt's powers. Scarcely any specialist of to-day is really master of all the work which has been done in his own comparatively small field. Facts and their classification have been accumulating at such a rate, that nobody seems to have leisure to recognize the relations of sub-groups to the whole. It is as if both in Europe and America individual workers were bringing their stones to one great building and piling them on and fastening them down without regard to any general plan or to their individual neighbor's work; only where some one has placed a great corner-stone, is it regarded, and the building then rises on this firmer foundation more rapidly than at other points, till it reaches a height at which it is stopped for want of side support. Yet this great structure, the portions of which are beyond the ken of any individual man, possesses a symmetry and unity of its own, notwithstanding its haphazard mode of construction. This symmetry and unity lies in scientific method. The smallest group of facts, if properly classified and logically dealt with, will form a stone which has its proper place in the great building of knowledge, wholly independent of the individual workman who has shaped it. Even when two men work unwittingly at the same stone they will but modify and correct each other's angles." *

* "The Grammar of Science," 1892, pp. 15, 16.

Any one who realizes how completely the animus of scientists is materialistic, and how constantly appears the sneer against all that is called God or that is worshipped, will recognize in Dr. Pearson's great building a modern tower of Babel, and in the disorder, independence and cross-purposes among scientists, where he yet thinks there is symmetry, will recognize a most formidable confusion of tongues. Already it is quite apparent, to one who investigates with a suspicion of the fact, that wherever one branch of science has upreared its hypothesis against the Bible, all this part can be easily exposed, simply by bringing against it scientific truths which have been worked out in some other departments. And this is simply what any real believer in the Bible, as God's voice to man, will anticipate. If the book of nature is but another witness from the same God, why not expect that a more complete investigation of natural phenomena, in all lines, will afford the data for demolishing the immature anti-Scriptural deductions in any particular line? But the Christian must step in and make the exposure; he cannot hope that those who have built up lofty personal reputations on such erroneous deductions will take pains to expose themselves! And let no Christian deceive himself in thinking that modern science is willing to make a permanent truce, divide up the territory, and leave the Christian in undisputed possession of a small section. The arrogant egotism of the materialistic scientist is well set forth in concrete example by Dr. Pearson, in the following passage:

"Science stands now with regard to the problems of life and mind in much the same position as it stood with regard to cosmical problems in the seventeenth century. Then the system-mongers were the theologians, who declared that cosmical problems were not the 'legitimate problems of science.' It was vain for Galilei to assert that the theologians' classification of facts was hopelessly inadequate. . . . It took nearly two hundred years to convince the whole theological world that cosmical problems were the legitimate problems of science and science alone. . . .

"We must here investigate a little more closely what the man of science means when he says: '*Here I am ignorant.*' . . . If the ignorance really arises from the inadequacy of the scientific method, then we may be quite sure that no other method whatsoever will reach the truth. The ignorance of science means the enforced ignorance of mankind. . . .

"If I have put the case of science at all correctly, the reader will have recognized that modern science does much more than demand that it shall be left in undisturbed possession of what the theologian and metaphysician please to term its 'legitimate field.' It claims that the whole range of phenomena, mental as well as physical—the entire universe—is its field. It asserts that the scientific method is the sole gateway to the whole region of knowledge. . . . The touchstone of science is the universal validity of its results for all normally constituted and duly instructed minds. Because the glitter of the great metaphysical systems becomes dross when tried by this

touchstone, we are compelled to classify them as interesting works of the imagination, and not as solid contributions to human knowledge." *

When he wrote this book Dr. Pearson no doubt thought it perfectly safe to select Newton's law of gravitation as an example of the difference between scientific infallibility and these "works of the imagination." Indeed, if the law of gravitation could not be trusted, where should he hope to find an absolutely impregnable scientific pedestal from which to look down in lofty and frosty superiority upon the religious world? But time has its revenges! The following crushing argument of Dr. Pearson is an example:

"The philosopher who propounds a new system, or the prophet who proclaims a new religion, may be absolutely convinced of the truth of his statement; but it is the result of experience from time immemorial that he cannot demonstrate that truth so that conviction is produced in the mind of every rational being. . . . On the other hand, a formula like that which Newton propounded for the motion of the planetary system, will be accepted by every rational mind which has once understood its terms and clearly analyzed the facts which it resumes. One system of planetary gravitation is accepted throughout the civilized world, but more than a dozen distinct theological systems and almost as many philosophical schools hardly suffice even for our own country. This is sufficient to indicate that there must be some wide difference between theological and scientific formulæ." †

It never occurred to this philosopher that in a very few years after thus delivering himself, even orthodox astronomers and mathematicians would be forced to look askance at Newton's law! And mark the keen logic of Dr. Pearson, in proving that gravitation is an eternal truth, because "accepted throughout the civilized world!" He thus very ably shows that the Ptolemaic system was also an undoubted eternal truth during all the period when it was likewise "accepted throughout the civilized world!" Hence we agree with Dr. Pearson that "the study of fallacy in concrete examples ought to play a greater part in our educational curriculum," and respectfully suggest that his own volume be given a place as a leading text-book!

If in so brief a space it is possible to show the fallibility of astronomical theory, or that its foundation is still mere hypothesis,—and that largely by collating the confessions of astronomers themselves,—it can scarcely be doubted that the same exertions would make an even more gaping breach in the anti-Scriptural assumptions found in any other branch of science.

Geology ranks next to astronomy in the appeal made to it against the credibility of the Bible. We have already seen, incidentally, that the great features of testimony rendered by the strata of the earth's crust are really striking in their confirmation of the Biblical account of a double creation, instead of being antagonistic to it. And the moment we have called into

* *Ibid.*, pp. 24, 25, 29, 30.

† *Ibid.*, pp. 93-4, with foot-note.

question astronomical theory, we deliver ourselves from imposition at the hands of materialistic geologists, who often seek to reinforce by an appeal to astronomy their unscientific wresting of the geological facts, to serve a strong anti-Scriptural bias.

After astronomy and geology, Darwinian evolution is the scientific weapon now most used against the Bible. But he who challenges the truth of all the anti-Scriptural elements in astronomical and geological science, throws back upon the evolutionist, with a demand for their proof, the two preliminary assumptions which afford the only plausible arguments ever marshalled for his anti-naturalistic postulate. The nebular hypothesis of astronomy is the parent of the absurd dogma of evolution; while the latter also seemed confirmed by geological science, in the general indication that vegetable life preceded animal life in the prehistoric ages, while lower forms of animal life preceded the advent of man. But the nebular hypothesis of astronomy is itself in sad need of rational confirmation. Again, geological science utterly fails the evolutionist in the striking testimony, in agreement with Scripture, of a complete break in continuity between the geological ages and the age-times of human history. In seeking arguments within the historic period, the evolutionist is confronted with the astonishing fact that every one of the fundamental points are against his postulate. (1) Weismann's maintenance of the continuity of the germ-plasm from generation to generation, so that the seed-germ propagated by the first parents of a species is exactly reproduced in each successive fertilization and transmitted intact to the end of the line, cuts down at the root Darwin's fundamental postulate of the transmission of acquired variations. This is in strict accord with the account of Gen. i., where each species of animal is recorded as created "after his kind," with each vegetable species similarly created, "whose seed was in itself, after his kind" (v. 12). (2) Nature everywhere sets her seal to this by the well-known facts, that when species of flowers or animals are crossed the hybrid is generally without power to propagate its kind, that animals carefully cultivated to change their characteristics tend rapidly to relapse, and that cultivated or engrafted vines and trees give seeds which perpetuate the original stock. Thus nature abhors a confusion of species, as she is said to abhor a vacuum. Such an arraignment of an hypothesis in its foundation would suffice an unbiased truth-seeker—would suffice anyone except a "scientist"! (3) Vegetation, animal life and man, instead of development toward perfection, show a marked degeneration in size from early times to the present, man having suffered similarly in the matter of longevity. The animals known to man are pigmies beside the prehistoric species whose skeletons are found. (4) The history of all the nations of the earth—raised up in God's providence, corrupting themselves, and rotting away or cut down through providential judgments—demonstrates that the law of human development is a law of tendency toward degeneration, and not of capacity for permanent self-improvement. The nation of Israel, launched on its course even with the great advantage of special light from

God, soon brought itself under condemnation. Under still greater favor of God the dominion passed to the Gentile nations of Christendom, who have been thoroughly tested in the supreme light of the life of Christ, and with the revelation of God's love and goodness. What is the result? National bloodthirstiness, with the blight of infidelity rapidly casting its pall over the so-called "Christian" nations, and which apparently is the precursor of those judgments of outraged Love which the New Testament predicts—the doom of Christendom foretold as to occur just prior to the advent of the long-predicted Messianic kingdom in the earth!

Again, just as evolutionists have built upon no better foundation than the assumption of the nebular hypothesis, and of the continuity between the geological ages and the age of man, so is the present phase of "higher criticism" of the Bible built upon nothing better than the assumption of Lamarckian-Darwinian evolution. It is a case of one airy superstructure projected by the fertile imagination upon another! The dominant style of criticism—of the De Wette-Reuss-Vatke-Keunen-Welhausen school, with Cheyne-Driver-Briggs echoes, and numerous other variations, in England and America—represents the third somersault of "higher criticism," and its fourth contradictory phase! (And I take no account in this remark of the perpetual contradictions in detail, among the numerous infallibilities of each school.) The philosophy of the present school is very simple: We assume that modern science has shown that the law of upward development underlies human history; but the Hebrew Scriptures perversely contradict this dogma, claiming that Israel started with a perfect law and departed from it, plunging into idolatry, instead of starting as nomad idolaters and evolving the Mosaic law out of their inner consciousness. The Hebrew Scriptures thus teach the heresy of degeneration, in place of evolution; therefore the testimony of the Hebrew Scriptures is incredible on its face, and the scientific way to arrive at the truth is to pronounce the records "pious frauds," always believing the opposite of what is written! Q. E. D.!

My reply to each of these curious theologians is as follows: My learned friend, you are too superstitious, and have been led away by your simplicity and childish faith in scientific infallibility! Are you so unskilled in human nature as to believe all the scientists tell you? Pray, do not assume so much, but try and establish your fundamental premise. First prove the doctrine of evolution, since no evolutionist has been able to demonstrate it for you; prove your assumption of geological continuity, since no geologist is able to do so; try and establish the tenets of astronomy, since the astronomers are in such sore need of assistance, instead of being able to lay a foundation for anyone else; and when you have done this, then we will be ready to look at the Scriptures on the ground of your premise, to see whether they confirm it, or expose it and you!

When that learned critic, Dr. Sanday, assures me from his printed page that the word of Christ is not sufficient authority for a Christian, since it is plain our Saviour was not always accurate, He having been guilty of "imper-

fect science" in saying that God "maketh the sun to rise," I must be permitted to reply: My dear Doctor, perhaps I should not blame you for taking this little question about the sun for granted, since all the world does so; yet since you profess to believe that the One you criticise for 'imperfect science' is and then was the God who had made the sun and whose word was then maintaining its operations, before positively asserting that He made a mistake in this case, even in the way of accommodation or condescension [!], ought you not to have abandoned theology for a few years and have first settled, beyond the possibility of doubt, this little question about the sun and the earth, which astronomers have for so many generations quarreled over? Just conceive for a moment as possible, what you may consider but the one chance out of ten million, that the sun *does* actually rise after all; and suppose that the day has arrived when you are standing before the throne of Immanuel Himself, and that you are reminded of these words, and are shown all the fruit they have produced in the world, in aiding and abetting and engendering unbelief in God's people—and in lost souls, some of whom had your help in their determination to go down to death without a Saviour!

It is on such grounds as these, my dear General, that I commend the publication of the translation of the lecture of Dr. Schoepffer. If it enables even a single soul to throw off the shackles of mere superstitious reverence for scientific dogma, and of blind subserviency to a priestcraft which abuses its authority as shamelessly as does that which dons the religious frock, the consequence for good may be incalculable. What I now esteem as the most precious truth, I once spurned under the inspiration of scientific negation; and, having been delivered from the thralldom of the latter, I consider myself in this like some poor bird which has been released from the net of the fowler, and permitted to soar into the blue depths of the heavens!

Very truly, FRANK ALLABEN.

NEW YORK, December 5, 1899.

While I fully endorse all the scientific views, and the deductions therefrom, expressed in the foregoing Supplement, yet it also contains what I must term theological abstractions to which I cannot subscribe. This remark is made because—while I respect, honor and esteem the author, and believe him to be the most conscientious man in religious matters I have ever met—we do not always coincide. In such cases I am willing to concede that his judgment is thoroughly honest; but I am not prepared, nor do I dare, to agree with him. As to his scientific attainments, they are unusual; and in most matters we do agree, but not in all. Therefore, as I read the proofs, this note is due to my feelings of responsibility.

ANCHOR (J. W. DE P.)

employ them to the best advantage. He computed the first table of refractions, and if it extended only to 45°, the reason was, that the effects of refraction, at a higher altitude, were altogether insensible to his instruments. His solar tables were brought to so great a degree of exactness, that he affirms he could never detect an error in them exceeding a quarter of a minute; but there is reason to suspect some exaggeration in this statement, particularly as Cassini, a century after, with much better means, could scarcely answer for errors of a whole minute. He (Tycho Brahe) contributed greatly to the improvement of the lunar tables, and detected a considerable inequality in the moon's motion in longitude, to which he gave the name of the *Variation*, by which it has ever since been distinguished. He also discovered an equation in latitude similar to the evection which had been observed by Hipparchus, and fixed its amount with great accuracy. He remarked the fourth inequality of the moon in longitude, although he failed in his attempt to ascertain its amount, or assign its law. He represented the inequalities of the motions of the nodes, and in the inclination of the lunar orbit, by the motion of the pole of that orbit in a small circle round the pole of the ecliptic. He demonstrated that the region of the comets is far beyond the orbit of the moon, and determined the relative and absolute positions of 777 fixed stars with scrupulous exactness, which gave his catalogue an immense superiority over those of Hipparchus and Ulugh Begh; and he left to his successors a regular series of observations of the planets, amassed for the purpose of establishing the truth of his own system, but of which Kepler made a better [?] use by employing them to establish the system of Copernicus. . . . The great mass of accurate observations accumulated by Tycho furnished the materials out of which his disciple Kepler may be said to have constructed the edifice of the universe." *

In the same treatise, Professor Proctor—himself one of the most zealous of the disciples of Copernicus, Kepler and Newton—furnishes us with his remarkable admission that Tycho Brahe's hypothesis in explanation of the movements of the heavenly bodies is quite as rational as the Copernican system, in its capacity to explain all the observed phenomena. Mr. Allaben has cited this in part; it is here given more in detail. Professor Proctor's remarks on the subject, with the accompanying diagram, illustrating the system of Tycho Brahe, are here reproduced ("Encyclopedia Britannica," Ninth Edition, Vol. II., pp. 777-8):

"Far more reasonable [than the Ptolemaic system] was the ancient Egyptian system, by some described as identical with, but in any case closely resembling in essentials, the system of Tycho Brahe, shown in Fig. 19 [See illustration].

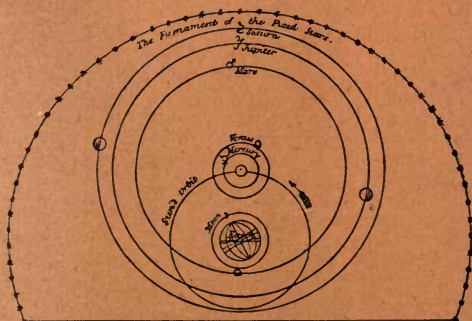


Fig. 19.—(Tychonian System) referred to by Prof. Proctor.

* "Shortly before his death he had been joined by Kepler, who owes his fame to the lesson of careful observation and cautious inference impressed on him by Tycho."—Article, "Tycho Brahe," "Encyclopedia Britannica," Ninth Edition, Vol. IV., p. 200.

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able symmetry of the universe, an harmonious disposition of the orbits. For who could assign to the lamp of this beautiful temple a better position than the centre, whence alone it can illuminate all parts at once? Here the sun, as from a kingly throne, sways the family of orbs that circle around him! It is hardly necessary to point out that the arrangement suggested by Copernicus explains the motions of the sun and moon as readily as the [Tyconic] system which presents both these bodies as moving around the earth."

When a modern astronomer, like the late Professor Proctor, pleads for the Copernican system on the ground that it is *the equal* of the Tyconic system, in capacity to explain observed phenomena, it is plain that the Tyconic system is worthy of profound respect, and that any plea in its favor deserves serious attention from unbiased minds.

ANCHOR (J. W. de P.)

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